Vol. XVII, No. 6
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Industrial Quality Control is published monthly by the American Society for Quality Control, Inc. Entered as second-class matter on Sept. 18, 1950. Second-class postage paid at the post office at Milwaukee, Wis., and at additional mailing offices.

Industrial Quality Control is sent to all members of the Society as one of the privileges of membership. Subscriptions from non-members are not accepted. Subscriptions for members *only* are $3.00 of the annual membership dues. Subscriptions for company, public, and university libraries are: 1 yr.—$9.00; 2 yrs.—$17.00; 3 yrs.—$25.00; 5 yrs.—$40.00. Back issues of Vols. I-X are available at $6.00 per volume including index; Vol. XI, $9.00; XII-XV, $10.00 ea. Individual copies are $1.00 each. Microfilm editions by volume are also available. The cost per volume is: I-VII, $10.00; Vol. VIII, ff., $2.00 ea.

Orders for library subscriptions, back issues, and microfilm editions should be accompanied by remittance made payable to the American Society for Quality Control, Inc. *Orders under $3.00 must be accompanied by remittance.*

Industrial Quality Control is regularly indexed in the *APPLIED SCIENCE & TECHNOLOGY INDEX* published by The H. W. Wilson Company, 950 University Avenue, New York 52, N. Y.

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Notification of address change should be sent to the secretary of your section and to the Executive Secretary's office. Allow approximately seven weeks for the change to become effective.

Executive Secretary and Publications office: Rm. 6185 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin. Society's New York Address: Rm. 949B, 463 West St., New York 14, N.Y.

Address all correspondence to American Society for Quality Control, Inc., Rm. 6185 Plankinton Bldg., 161 West Wisconsin Avenue, Milwaukee 3, Wisconsin.

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INDUSTRIAL QUALITY CONTROL

Vol. XVII, No. 6 December, 1960

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ALBERT GREEN **000:10;30;40;50:400**

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9 **Quality Control from Front Door to Back Door**
SIGMUND P. ZOBEL **300:10:000**

The author contends that a truly effective quality control system cannot exist without a closed-loop type of information flow, resulting in what he calls the Quality Control Wheel, with statistical quality control as the hub and design, manufacturing and sales located about the circumference.

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From the President's Desk

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Many times in our efforts to justify the importance of our individual quality control programs to our management, we get lost in showing scrap savings and the other dollar and cent values of our QC programs. There is certainly nothing wrong with this. Indeed it is an important viewpoint we must use in talking to our management.

But in our enthusiasm for cost savings, we have overlooked a truly significant area. The most important contribution that a good quality control program can make to a company is a better product resulting in more satisfied customers and fewer customer complaints.

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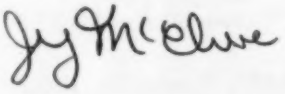

The Legal Framework for

Inspection Under Government Contracts

ALBERT GREEN, *Office of the General Counsel, Department of the Navy, Washington, D.C.*

Inspection Provisions Generally

Importance of Inspection Clauses

A large number of the disputes between the government and its contractors arise out of differences over the inspection and acceptance of the contractors' work. The inspection provisions in government contracts govern both (i) the procedures for determining whether the supplies or work tendered by the contractor are acceptable and (ii) the rights and obligations of the parties if the supplies or work do not meet contract requirements.

Types of Inspection Provisions

Different inspection clauses are provided for the various kinds of contracts such as fixed-price supply contracts, fixed-price construction contracts, cost-type research contracts, etc.

In addition to the inspection clauses, contracts generally contain one or more other provisions affecting inspection and acceptance. Examples of such other provisions are: supplementary inspection provisions; guaranty clauses; designations of places of inspection, delivery and acceptance; provisions for inspection of preproduction samples; and provisions in specifications for tests, inspection and contractor quality control requirements.

ASQC LCS Codes 000:10;30;40;50:400

Albert Green is a member of the Kentucky, New York, and District of Columbia Bars. The views expressed are not necessarily those of the Department of the Navy.

This article was originally presented as an address at the Sixth Annual Government Contracts Institute, Lisner Auditorium, Washington, D.C., May 7-8, 1959, cosponsored by The George Washington University and the Federal Bar Assn.

Responsibility for Inspection

Final responsibility for acceptance must be vested in government personnel. In 1926, the Comptroller General refused to permit the Navy to rely on the decision of tea inspectors who were not Government employees, and held that government purchases must be inspected by persons responsible to the government acting under government supervision.(1)

But the government may utilize inspection or testing services of commercial laboratories, trade associations, and other non-government agencies. It may also rely on the inspection system, record and certificate of the contractor. The Comptroller General approved requirements that lumber be grade marked or certified by private inspection or grading associations, where their services were available to non-members, provided the lumber was subject to final inspection and acceptance by government personnel.(2) He distinguished this case from the Navy tea case on the ground that the inspection by the lumber association was not a final and binding determination on which payment of appropriate moneys would be paid. Notwithstanding his earlier ruling in the Navy tea case, in 1954 the Comptroller General allowed the Army to have its coffee inspected and approved by graders selected by the National Coffee Association. The graders issued certificates of approval which, when accepted by the contracting officer, were final.(3) The decision was based on the practice in the coffee industry and the inability of the government to employ qualified coffee graders.

Standards of Inspection — Equitable Adjustment

Where the inspector requires performance in excess of that called for by the contract, the contractor is held to be entitled to an equitable adjustment under the Changes clause.(4) Also, where the contract leaves to the contractor the selection of the way in which the job will be done, if the inspector requires the contractor to perform in a specified manner, there is a change in the specifications which may give rise to an equitable adjustment.(5) Where the inspector is not expressly authorized to order changes under the Changes clause, the propriety of holding that he has such authority has been contested by attorneys for the government, but the Board of Contract Appeals has held that the inspector has full authority to discharge his mission.(6)

If the contract or the specifications do not prescribe the method of inspection the method used must be reasonable. For example, where the inspector used wooden dowels to find leaks in cans of blueberries, the Board of Contract Appeals held that this method was unreasonable because it damaged the cans.(7)

The government does not agree

in the Inspection clauses that it will perform any inspection work, but it is sometimes held to be obligated to do so. A contract for parachute ripcord releases gave the government the right to terminate the contract if two successive lots of pre-production samples failed to pass 17 kinds of tests. Tests of the first lot were discontinued after three kinds of tests had been made and three major discrepancies found. All 17 tests were made on the second lot and while several other discrepancies were found they were not the same as the ones found in the first lot. The contract was terminated and on appeal it was held the Government had a duty to put the first lot through all 17 tests so that the contractor would be apprised of the defects and have an opportunity to remedy them before the second lot was submitted for testing.[8]

Fixed-Price Supply Contracts

Provisions for Inspection

The Inspection clause for fixed-price supply contracts authorizes the government to inspect and test, not only the end items, but also the raw material, components and intermediate assemblies. They may be inspected at any practicable time or place and at any stage of manufacture, including the plants of sub-contractors. The *Golden Gate Products*[9] case involved a contract for strawberry preserves. Inspection plans, signed by both parties to the contract, called for in-process inspection at all times. The contractor processed three batches before the inspector arrived at 8:30 one morning and the inspector rejected them because he thought their fruit content was insufficient. However, these three batches were nevertheless shipped and commingled by the contractor with several days production that had passed inspection. The contracting officer being unable to identify the three batches, rejected the entire shipment for lack of required "in process" inspection and his decision was upheld by the Board of Contract Appeals.

The Court of Claims was more lenient in the *Atlantic Fish and Oyster*[10] case, where the contract provided that shrimp being purchased should be processed under the supervision of an Army Veterinarian. The inspector refused to accept the shrimp because they had been beheaded at sea and the contract was terminated for default. The court found that beheading shrimp at sea was good commercial practice and was not a proper reason for rejecting them. However, the default termination was upheld on other grounds.

Cost of Inspection

The cost of inspection must generally be borne by the buyer, unless the contract provides otherwise.[11] The Inspection clause requires the contractor to provide reasonable facilities for the safety and convenience of the inspector when inspection is conducted on the premises of the contractor or subcontractor; if conducted elsewhere, inspection is to be at the expense of the government. However, in one case, the contractor was held liable for the cost of inspecting 30,000 cans of shortening after they had been delivered to an Army depot.[12] The contract provided that if supplies were improperly packed or crated the government could *repack* or *recrate* them at the expense of the contractor. Some of the cans had been punctured by nails which held down the box tops. The contractor, relying on the provisions of the inspection clause, refused to furnish labor to open up the boxes and inspect the cans. So the Army opened all the boxes and found 1/30 of the cans punctured. The contractor was held liable for the cost of opening and inspecting all of the boxes.

Contractor Inspection

The contractor may be required to establish and maintain an inspection system acceptable to the government. He must keep records of his inspection work and make them available to the government. These requirements are to reduce the amount of government inspection, particularly on large contracts and those involving an extended period of manufacture.[13]

An inspector was held to be justified in refusing to inspect as long as the contractors' in-process procedures failed to comply with the Military Specification[14] imposing general quality control requirements on the contractor. Because of the contractor's inadequate inspection procedures the inspector stopped accepting supplies while he went to what he called 100 percent "in-process" inspection. The Board held that under the contract the inspector could have performed 100 percent in-process inspection, but that he was actually refusing to inspect, and was not justified in refusing to inspect after the contractor's in-process procedures had been corrected.[15]

Acceptance and Rejection

Under fixed-price contracts, the government may either (i) reject defective supplies (with or without instructions as to whether they should be corrected) or (ii) require the contractor to correct them at his expense.

The Board of Contract Appeals has consistently held that the government may insist on strict compliance with the specifications. In the *Consolidated Cordage*[16] case, it appears that the manila rope being purchased contained less than one percent excess lubricant. The Board upheld a termination for default despite the contractor's contention that this excess lubricant in no way impaired the serviceability of the rope. In the *Arrow-Lacquer*[17] case, gray paint delivered was rejected because it was slightly darker than the dry color chip which it was supposed to match. The rejection was upheld even though the contractor pointed out that within four hours after the gray paint was applied, it would be covered with a coat of white paint.

The Inspection clause provides that acceptance or rejection shall be made as promptly as practicable after delivery. But it expressly provides that failure to accept or reject supplies will not relieve the contractor of responsibility for defective supplies nor impose liability on the government for them. Notwithstanding this last mentioned provision, unless the government gives the contractor notice of rejection within a reasonable time, it will be held to have accepted the defective items. What constitutes a reasonable time depends on the facts of each case. Three and one-half months was held unreasonable where the defect was obvious and should have been noticed upon receipt.[18] Where an unreasonable amount of time is taken for inspection or testing, the fact that the contracting officer gives notice of rejection promptly after receipt of the inspection report does not make the notice timely.[19]

The contractor must remove the

rejected supplies unless the contracting officer requires or permits them to be corrected in place. It is the policy of the Department of Defense to give contractors an opportunity to correct or replace nonconforming supplies where they can do so before the required time for delivery.[20] The Inspection clause provides that if the contractor fails to promptly replace or correct the defective supplies, or to remove them when required by the contracting officer, the government may either (i) have them replaced or corrected at the expense of the contractor or (ii) terminate the contract for default. Termination for default appears to be the more common practice, and under the Default clause the government can charge the contractor the excess cost of procuring similar supplies elsewhere. If the contractor does not correct the supplies by the time specified for delivery, the contracting officer can require him to deliver them at an equitable reduction in price. Where supplies are rejected because of minor defects, contractors frequently contend that the government should accept the supplies at a reduced price. But it is well established that contractors cannot compel the government to accept the defective supplies.

Finality of Acceptance

The Inspection clause for fixed-price supply contracts provides that "except as otherwise provided in this contract," acceptance is conclusive except for latent defects, fraud, or gross mistakes amounting to fraud. The "except as otherwise provided" language in this provision permits the use of a separate Guaranty clause where inspection and acceptance tests are considered inadequate to detect defects and deficiencies. Guaranty clauses generally provide that the contractor guarantees that at the time of delivery the supplies will be free from defects and will conform to contract requirements. They also provide that if notice of defects is given within a specified time the contractor may be required either to correct them or to repay an equitable portion of the contract price.[21]

Latent defects are subject to the provisions for correction and replacement after acceptance to the same extent as patent defects are before acceptance. In the Appeal of *C. A. Dunham*,[22] the specifications in a contract for shells provided that "under any condition of inspection" if any material accepted contains *inherent defects subsequently exposed*, the contractor would replace the defective material. Despite the "except as otherwise provided" language in the Inspection clause, the Appeals Board said that if this provision of the specifications applied to patent defects it would be inconsistent with the Inspection clause and the Inspection clause, being in the General Provisions, would prevail over the specifications.

In the *Leon Supply*[23] case the contractor had lowered his price upon being told by the contracting officer that he might substitute a brand of floor wax for that called for by the contract. However the contract as drawn still called for the original wax with a high solid content. More than a year after final acceptance a different contracting officer terminated for default because of "latent defects." On appeal the Board held there was no latent defect because (i) the variance from the specification could have been discovered by the laboratory test at the time of acceptance, and (ii) the government knew what it was receiving when it accepted and paid for the substitute wax.

The *Haskins Brothers & Co.*[24] appeal involved an "F.O.B. origin" contract for soap. When the soap was loaded on the freight car the government inspector checked the number of cases, and remained present until the car doors were sealed. Upon arrival at destination the seals were unbroken but there were 36 cases less than the inspector had counted and accepted. The Board held that the contractor's responsibility ended when the soap was loaded and accepted by the government at the point of origin.

Cost-Type Contracts

Inspection Provisions

The Inspection clause for cost-type supply contracts contains provisions for inspection similar to those fixed-price contracts. It also provides that acceptance will be deemed to have been made no later than 60 days after the date of delivery, if not actually made earlier.

Correction of Defects

The provisions for the correction or replacement of defective or nonconforming supplies are very different from those in fixed-price contracts. In cost-type contracts no distinction is made between latent and patent defects.

Up until six months after *acceptance* of the last delivery under the contract, the government can require the contractor to correct or replace *any* supplies that were defective or deficient at the time of delivery. This six-month period may be varied in the contract. It runs, not from the last delivery, but from the acceptance of that delivery which may occur as late as 60 days after delivery. There is no limit on the time within which the contractor may be required to make corrections or replacements if the defects or deficiencies are due to fraud, lack of good faith or wilful misconduct on the part of his "managerial personnel" which are defined in the clause.

The government pays the Contractor the cost of correcting or replacing supplies unless the defect or deficiency was due to fraud, lack of good faith or wilful misconduct on the part of management. But no additional fee will be paid for correcting or replacing the supplies.

If the contractor fails to proceed promptly to replace or correct the supplies the government has four alternative courses of action. *First* it may have the supplies corrected or replaced and charge the contractor with any increase in cost to the government occasioned thereby; *or* (2) it may reduce the contractor's fee in an amount that is equitable under the circumstances; *or* (3) if the defective or deficient supplies have not been delivered, the government can require delivery and reduce the amount of the fee; *or* (4) it may terminate the contract for default.

Industry Objections to the Clause

During the development of the Inspection clause for cost-type supply contracts, industry representatives objected to several proposed provisions.

Industry was of the view that inspection should be final as to failures to meet specifications and that the six-month guaranty period should apply only to defects in workmanship and material. In refusing to accept this view the government pointed out that (i) since the six-month guaranty period was in lieu of a latent defects provision, there was no reason to distinguish between defects in material or

workmanship and other failures to conform to contract specifications, and (ii) it would be difficult in many cases to differentiate between the two kinds of defects.

As originally drafted the clause provided that the contractor could be required to correct defective or nonconforming supplies after the six-month guaranty period where the defect or nonconforming supplies were due to "fraud or wilful misconduct on the part of the contractor or any of its employees." Industry objected to this provision insofar as it would impose continuing liability on the contractor for defects caused by personnel other than top management. Industry argued (i) that the contractor might be unaware of such misconduct or might be powerless to take appropriate action and (ii) that the contractor might have returned to normal commercial production. The government representatives answered that the contractor would be paid for the cost of correcting or replacing the supplies where top management was not at fault and that, where the contractor would have to reinstall a production line, the cost would be so high that the government would not order the supplies corrected or replaced. They also pointed out that the contractor could subcontract the work. The Material Secretaries of the Military Departments agreed with industry on this provision and it was revised accordingly.

Originally the clause would have considered defects to be the fault of management where through lack of good faith or wilful misconduct management selected or retained the individual employees responsible for the defects after management had reason to believe that the employees were "careless or otherwise unqualified." Industry recommended that these words be changed to "habitually careless or grossly incompetent." Industry also stated that because of labor laws and union contracts it was not always in a position to discharge unqualified employees. The government pointed out that if management was not able to discharge the employees for those reasons, such failure would not be due to lack of good faith or wilful misconduct. The words "habitually careless or otherwise unqualified" were adopted.

Industry also objected to the provisions that the contractor may be charged with any increased cost to the government of having defective supplies corrected or replaced where the contractor failed to correct or replace them. However, this provision for excess costs was retained because, in some cases, other penalties in the Inspection clause would not fully compensate the government where it is compelled to have someone else do the replacement or correction work.

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(8) Zenith Instrument Co., Inc., ASBCA No. 4664, 59-1 BCA 2004 (1959). See also Terry Industries discussed below.
(9) ASBCA No. 5122 (Mar. 16, 1959)
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(11) See Judson Pacific-Murphy Corp., ASBCA No. 3157 (1956)
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(15) Terry Industries, Inc., ASBCA No. 3718, 59-1 BCA 2072 (1959)
(16) ASBCA No. 3556, 58-2 BCA 2020 (1958)
(17) ASBCA No. 4667, 58-2 BCA 2003 (1958)
(18) J. C. Woody Printing Co., ASBCA No. 1646 (1954)
(19) J. H. Rutter-Rex Mfg. Co., ASBCA No. 1955 (1954)
(20) ASPR 14-107 (July 22, 1960)
(21) See Navy Procurement Directives, 7-103
(22) ASBCA No. 2008 (1954)
(23) ASBCA Nos. 1762 and 1870 (1955)
(24) ASBCA No. 1932 (1954)

Our Cover

World Adopts New Standard of Length

A National Bureau of Standards scientist adjusts a krypton-86 lamp in its liquid nitrogen bath.

The wavelength of the orange-red light emitted by the lamp was adopted Oct. 14 as the International Standard of length. The lamp is operated at the triple point of liquid nitrogen, 63° K, to increase the stability of the standard wavelength.

The new definition of the meter as 1,650,763.73 wavelengths of the orange-red line of krypton 86 will replace the platinum-iridium meter bar which has been kept at Paris as an international standard for length since 1889 under the Treaty of the Meter.

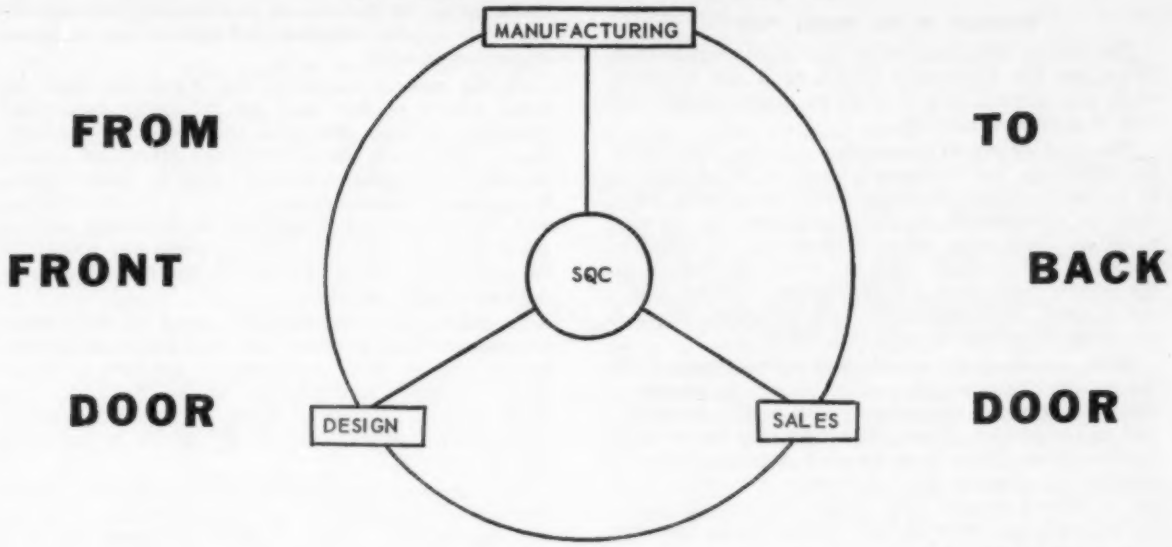
The new definition of the meter relates it to a constant of nature which is believed to be immutable and can be reproduced with great accuracy in any well-equipped laboratory. Also, it is possible to measure some dimensions more accurately in terms of the new definition than was possible before.

The meter bars, which have served as standards of length throughout the world for more than 70 years, will not be discarded or placed in museums, according to the 11th General Conference on Weights and Measures, which took the action during a meeting that was held in Paris.

Dr. Allen V. Astin, director of the National Bureau of Standards, U.S. Department of Commerce, headed the American delegation to the Conference.

The delegation also included Louis Polk, president, Sheffield Corp.; Elmer Hutchisson, director, American Institute of Physics; A. G. McNish, chief, Metrology Division, National Bureau of Standards; T. H. Osgood, U.S. Scientific Attache, London, and Martin Van Heuven and Benjamin Bock, U.S. State Department.

QUALITY CONTROL



SIGMUND P. ZOBEL

The Carborundum Company, Niagara Falls, N.Y.

Introduction

It is a well known fact that properly located jewels in a watch make for more efficient and reliable performance of the timepiece.

A quality control system is the set of jewels for the mechanism known as an industrial establishment. A minimum number of jewels is usually necessary for a reasonably good watch; too many jewels are redundant, some of them doing no good at all.

It is precisely the same with a quality control system. A minimum number of control points is required for an adequate system; but it is quite possible to go overboard and design a system which contains so many controls that some of them represent wasted effort. The sensitivity and complexity of the mechanism dictate where and how many controls are required.

By knowing a bit about the what, who, where, when, how, etc. of quality control it becomes possible to start putting it to use, or to enhance its usefulness if already present.

Definitions

Quality may be defined for the present purpose as a high degree of conformance of a product to its specifications. This implies that if one sets out to make a very good product, and succeeds in meeting his specifications, he has a quality product; otherwise, it is not of the correct quality. At the same time, if one deliberately sets out to make a low caliber product, and succeeds in making what he wanted to, he too has a "quality" product, for it conforms to his specifications. There is a further implication, of course, that the specifications must be valid ones.

Next, consider a definition of *Quality Control*. Quality control means seeing to it that the customer gets what he believes he is buying. This entails whatever is necessary to accomplish such a mission.

ASQC LCS Code 300:10:000

All too often, it stands for inspection, sort, rework, re-inspection, scrapping mixes or pieces, etc., with a probable emphasis on final inspection. While this type of quality control is sometimes necessary as a beginning, there are very few industrial organizations in which it must or can remain like that. To improve upon the archaic, overly-expensive quality control practice of inspecting out the bad production, it is necessary to turn to what is involved in the next definition.

Statistical Quality Control is the use of good statistical practice to help make the product so it conforms to its specifications, and to ensure that what gets shipped contains no more than a reasonable proportion of defectives or number of defects. Now, this does not always require that fancy sophisticated techniques be used. In some instances, careful, regular record keeping may be all that is required. Other times, the basic kit-bag of sampling plans and control charts will be necessary in addition to the record keeping. And, some situations may require more sophisticated statistics, such as significance tests, designed experiments, etc. Regardless of the requisite degree of penetration into the body of statistical methodology, statistical quality control, given a fair chance, is the only kind that pays off ultimately in better quality conformance with lowered material usage, less rework, and probably reduced inspection man hours.

The Quality Control Wheel

A truly effective quality control system cannot exist without a closed-loop type of information flow, resulting in what may be called the Quality Control Wheel.

Statistical quality control is the hub. Information and advice must flow from it to the functions along the wheel, and from the functions along the wheel to the hub. At the same time, quality information must flow from the individual sections of the wheel back and forth to each other. This requires records,

reports, and procedures which are all part of a master plan.

Elements of the Master Plan

The master plan consists of the quality documents. These are the documents which spell out in detail what is required, how it is to be implemented, and how it is to be evaluated.

The first group of documents are the blueprints, the drawings, the engineer's description of *what* is to be made. These form the basis for quality decisions on dimensions, finish, assemblies, etc. as well as often containing other descriptions or requirements of the product, such as hardness. Prints are the source documents for productive activity. Without a good, fully descriptive set of prints, there is no guide to certain quality attributes.

Next, are those documents that indicate more fully the quality characteristics which should be present in the product at the respective stages of the processing and at completion. These, of course, are the product specifications. With these detailed specifications it is possible to construct the full domain of possible items for a control system, from which the specific attributes requiring controls will ultimately be selected.

A third set of documents describes the manufacturing procedures in detail. Study of the procedures is critical to an efficient selection of in-process control points. A procedure which has been found useful is to prepare a flow sheet of the process. This may be very elaborate or very condensed.

Such a flow sheet indicates the principal types of operational centers in the overall process. From the written descriptions of the manufacturing procedures, each center may be exploded into a subflow sheet which permits identification of when and where an operation takes place that results in a determinable change in one or more quality characteristics. Once this has been accomplished, the door is opened to the work required for building the quality control system, which culminates in the fourth set of quality documents.

These are the specifications of the standardized and valid inspection and SQC routines which comprise the SOP. These must be sufficiently detailed so anyone can pick them up and learn what to do where and when, and what the decision rules and actions are. It might be noted in passing that these descriptions may serve as the basis for a Quality Control Manual which is desirable for internal use as well as in satisfaction of some customer requirements.

Support of the SQC Function

The best master plan cannot possibly work, of course, unless it is supported adequately by the proper persons and services. The order in which these shall be discussed is not in order of importance. Such an ordering would be difficult, if not impossible, to devise. All are important; all must be present for a total quality control system to be operative.

Inspection

Quality decisions cannot be made without data. To obtain these data it is necessary to make tests, measurements, chemical analyses, etc. Sometimes the data are generated by a visual examination resulting in recording the nature and frequency of the defects observed. Regardless of the manner of observing the quality characteristics, the act of making the observation may be called inspection.

Now since no statistical analysis is any better than the data used for the analysis, inspection personnel must be made to realize the importance of carefulness and accuracy in their work of observing and recording. This applies whether 100 percent or sampling inspection is used.

In the case of sampling, the inspectors must be made aware of the need for following prescribed sampling routines. Otherwise the element of randomness is lost, with the concomitant effects of loss of validity in the inferences which may be drawn therefrom, loss of discriminating power of the procedures, and loss of desired sensitivity in detecting quality shifts. It is no longer possible to make any meaningful probability statements, which are really the foundations of SQC practice.

In either case, the inspectors must be sufficiently trained and instructed so they will know what they are looking for, how to measure it, and how to record their findings. Control charts of the right kind are often helpful in spotting when an inspector may be the cause of apparent quality deviations in the product or material.

For the most part, the inspection function is exercised in three distinct areas: raw materials, in-process, and finished goods. At times, a fourth center of inspection is required at the warehousing or storage facility, since packaging, aging, etc. may affect the quality of the product as it is received by the customer.

Ideally, the precision and accuracy of each inspector or analyst in making his observations should be known, so they may be taken into account in examining the data. It is a well known fact that most individuals have their own form or quantity of bias and imprecision which is peculiar to them, but may differ from others.

Gage Control

It has been established that the inspection function is for the purpose of obtaining quality information, on the basis of which decisions are made by the inspectors or others. It was also mentioned that the inspector has a responsibility in exercising care to make the data good. But, no matter how expert and conscientious the inspectors are, they need to be given the opportunity to take good observations. This implies the need for a satisfactory gage situation. Now, what does this entail?

First, there must be suitable gages, instruments, recording devices, etc. Secondly, there must be a sound program of gage control. Calibrations must be accurate; hand instruments such as micrometers must be carefully and properly handled; meters and scales should be checked regularly; standards, whether physical or chemical, should be used as controls, etc.

Second, the accuracy and precision of the measuring devices or techniques should be known, just as it is desirable to know these facts about the inspectors and analysts. More than once there has been evidence of lack of control which was fallacious evidence, generated by virtue of the fact that the instrument or gage bias and imprecision, and/or the observor's bias and imprecision overshadowed the process variations. This can result in making a perfectly good process look bad.

Statistical Quality Control Procedures

For maximum effectiveness, statistical quality control procedures should be used to support the quality control function. A few will be cited below as tools which should be available and used if an adequate

control program is to exist. Not all of the procedures or devices are applicable in each situation, certainly. But potentially, each has its role, as do many other statistical applications not included here.

First, consider what may be termed static situations. By this is meant a situation in which goods or material are to be examined for the purpose of making a decision to accept, to scrap, to rework, to screen, etc. The subject material exists; this is an after the fact situation. Such a case is commonly known as acceptance inspection, although more descriptive would be the terms "acceptance sampling" and "rectifying inspection." For the benefit of those to whom the latter term may be new, rectifying inspection is the term applied to the situation whereby a lot rejected by the sampling plan is screened, or 100 percent inspected, for removal of all defective units.

Any plan whereby n units are randomly drawn from a lot, and decision rules exist, such that if the number of defectives is $\leq c$, the lot is accepted, but if the number of defectives is $> c$, the lot is rejected, is a sampling plan. Variations of this are often used, as is well known. Sometimes a second sample may be required before a decision is reached. This is known as double sampling. Other times, a decision is possible after the first few, or after each succeeding unit or group of units. This is called sequential sampling or multiple sampling, respectively.

In order for any of these plans to give desired results, they should be selected according to a set of specifications of their own. These specifications, which are such considerations as acceptable quality level, producer's risk, lot tolerance level, consumer's risk, and average outgoing quality limit, comprise a set of parameters from which a sampling plan may be constructed, or by means of which an appropriate sampling plan may be selected from the proper tables.

Now, for dynamic situations, a brief consideration of what is commonly known as process controls may be made. Here, instead of a post mortem, the examination is of an exploratory nature. According to some plan, the yield or output of a going process is dipped into for the purpose of obtaining a sample which gives certain information about the process. This information permits a decision as to whether the process is remaining stable, is drifting, is out-of-control, etc. And, the usual device for facilitating such decisions is a control chart.

A word of caution may be appropriate here. The control chart can do no more than show what is going on, what has gone on in the past, and, sometimes, what may occur in the near future. It can only give signals for someone to act upon. Successful use of control charts requires skillful reading of the signals, and prompt action when it is indicated.

In addition, successful control chart applications require knowledge of the limitations of each chart, to prevent misuse of the data and recognition of when a different chart may be required for a given purpose. Another warning to bear in mind is that a control chart is not a mystic panacea. The chart *per se* does nothing but plot data against certain decision rules. It merely puts the data in a context such that certain routine, clear cut decisions on process quality may be clearly indicated to any unskilled observer. Perhaps this is the clue to the great success that properly applied routine control charts and sampling plans may obtain. The fact that data are being routinely collected and put into a form so a case history emerges can, of itself, no doubt account in part for the success of a quality control program.

Now, SQC does not end with statistically founded sampling plans and control charts. These are only a small part of the various statistical services any company can use to good advantage in making a better product at the same or lower costs, or the same quality product at lower costs.

Process capability studies are an extremely important phase of SQC. Indeed, it may be submitted that without process capability knowledge, there is little basis for even accepting a job for production, unless it is possible to immediately start collecting the data needed to establish the process capability. Knowledge of process capabilities indicates whether or not specifications are too tight or too loose in terms of economic production. For example, if a stated tolerance is less than the natural tolerance the process is capable of, then a high reject rate can be expected; on the other hand if the stated tolerance is much more than the natural process tolerance, a product better than required may be made.

Many other statistical activities are now considered as belonging within the scope of SQC, if an acceptable interpretation of the goal of SQC activities is to work in the direction of minimizing costs while stabilizing or enhancing quality of product. Without discussion, one may cite such important contributions to an overall plant effort that can be made by the slightly more sophisticated techniques of statistical inference, designed experiments for both production and research or development purposes, evolutionary operation, operations research, the use of computers, etc.

Customer Relationships

SQC procedures can be useful in dealing with returns and field complaints, particularly if good production records and inspection records are kept. Not only will a statistical approach toward an analysis of returns and complaints pay off in pinning down real field quality problems as distinct from illusory problems, but it will also aid in determining the basic causes of real complaints and signal where in the production stream important quality lapses may be taking place, so they may be prevented or minimized in the future.

Another contribution which SQC can make towards the improvement of customer relations is by being prepared to tell the customer what the quality level of his purchase may be. Some companies go further than this and provide their customers with final inspection results, or even certify the lot quality.

Conclusion

The discussion immediately preceding has brought the reader to the front door of the industrial establishment. This is the beginning but by no means the end of the quality effort. Market needs dictate what shall be produced in the first instance. And, all activity from the front door to the back door of the shop is aimed at economic fulfillment of the market needs.

In order to accomplish this, the Quality Control Wheel concept must be followed. There must be continued communication among sales, technical, and manufacturing efforts; there must be cooperation, mutual respect, and sublimation of the individuals vested interests to the divisional or corporate best interests.

A Mixed Model Factorial Experiment In Testing Electrical Connectors

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Summary

This article concerns the statistical analysis of a test program to determine the force required to separate a set of electrical connectors under various conditions. The experimental results were evaluated by analysis of variance methods (the mixed model). A method by which information could be used to reduce the cost either through a saving in laboratory time or by a reduction in the number of connectors required for further experimentation, is described.

Introduction

Electrical connectors are electromechanical component parts which permit connecting and disconnecting electrical circuits. The most common arrangement of a connector consists of two separable sections: a set of mating pins, and a set of inserts, or sleeves, which receive the pins. The section containing the pins is the plug and the other section is the receptacle. The force required to separate electrical connectors is critical because it is often directly involved in the separation of two moving vehicles. In the separation of a satellite or missile from its booster, a lack of homogeneity in the force required for separating a set of like connectors might impart some initial instability in the vehicle which could cause a deviation from the intended trajectory.

Table I—Electrical Connector Data (Disconnect Force, Lbs)

Angle of Pull	Connector Number	Trial					Average
0°	1(43.9)*	46.5	43.0	46.5	44.0	46.5	45.3
	2(43.7)*	39.0	42.0	44.0	44.0	42.0	42.2
	3(42.1)*	37.5	40.0	41.5	40.0	39.0	39.6
	4(38.7)*	36.0	38.0	37.5	36.0	36.5	36.8
	5(49.6)*	46.0	44.5	44.0	48.0	46.5	45.8
							41.9
2°	1	42.5	43.5	45.0	45.0	44.5	44.1
	2	42.5	44.0	45.5	44.5	44.0	44.1
	3	39.5	39.5	37.5	38.0	37.5	38.4
	4	35.0	36.0	38.0	39.0	42.0	38.0
	5	44.5	46.0	48.0	48.0	49.5	47.2
							42.3
4°	1	43.5	43.0	43.0	42.0	42.0	42.7
	2	43.5	42.0	42.5	42.5	43.0	42.7
	3	42.0	42.5	42.5	42.0	44.0	42.6
	4	43.5	43.0	44.0	45.5	35.0	42.2
	5	49.5	51.0	46.0	47.5	50.5	48.9
							43.8
6°	1	43.5	45.0	41.5	44.0	43.5	43.5
	2	44.0	44.0	44.0	47.0	50.0	45.8
	3	47.0	48.5	47.0	47.5	49.5	47.9
	4	35.0	37.0	38.0	39.5	40.0	37.9
	5	52.0	53.0	57.0	59.0	61.0	56.4
							46.3
				OVERALL AVERAGE			43.6

* Averages of the 20 readings which were taken with the connector in question.

ASQC LCS Codes 520:60;70:436

Five connectors were tested in the laboratory, using a Riehle Tensile Testing machine. The objectives of the test program were as follows: (1) to estimate the force required to separate the plug from the receptacle under various conditions, (2) to determine to what extent the force is affected by the angle at which the connectors are pulled apart, (3) to estimate the variability between five connectors which are supposedly alike, (4) to estimate how accurately the tensile testing machine can reproduce the measurements.

The act of installing connectors of this type in the testing machine is a laborious and time consuming operation. For this reason, the economics of the problem dictated that each connector be separated five times at each of four successively increasing angles of pull, as opposed to randomly assigning the various angles of pull to the five connectors. This procedure results in a confounding (or mixing) of the effect of angle of pull with a possible deterioration in the force required to pull a connector apart. However, from past experience with the connectors in question, the property of connectors to deteriorate after a few separation tests may be considered negligible.

Analysis of the Experiment

The raw data for this factorial-type statistical experiment are presented in Table I. The data analysis was carried out by the least-squares technique and is expressed in an "analysis of variance" form in Table II. Analysis of variance is an arithmetical procedure for quickly separating the sources of variability in an experiment. The steps of the analysis are described in the Appendix.

The sources of variation in the analysis of variance (Table II) are expressed by each of the additive terms in the mathematical model, or pattern of behavior of the data, as follows:

$$y_{ijk} = m + a_i + c_j + (ac)_{ij} + e_{ijk}$$

This model is a way of indicating that each observation (y_{ijk}) in the experiment is composed of several

Table II—Analysis of Variance of the Data in Table I

Source of Variation	Degrees of Freedom	Sum of Squares	Mean Square	Expected Mean Square	F-ratios
Effects of Angle of Pull	3	290.79	96.93	$\sigma^2 + 5\sigma^2_{AC} + 25\frac{(\Sigma\alpha^2)}{3}$	2.56
Connectors	4	1234.83	308.71	$\sigma^2 + 20\sigma^2_C$	77.96*
Angle by Connector Interaction	12	455.03	37.92	$\sigma^2 + 5\sigma^2_{AC}$	9.58*
Trials in the Testing Machine	80	316.50	3.96	σ^2	
TOTAL	99	2297.15			

* The probability of obtaining such an F-ratio by chance is less than one in a hundred.

additive factors. In this problem the additive factors are the following: an overall mean, or average (m); a contribution associated with the angle at which the connector is pulled apart (a_i); a contribution associated with the particular connector that was used (c_j); the contribution $(ac)_{ij}$ associated by the fact that the effect of angle of pull and the connector contribution are not additive, i.e., there is an interaction between the connector and angle of pull; and, finally, the error (e_{ijk}) in the testing machine, which expresses the inability of the testing machine to reproduce the results exactly.

This model is known as a "mixed" model factorial because it contains both "fixed" and "random" factors. Thus, the contribution associated with connectors (c_j) is random in character because the five connectors chosen were selected at random from a predetermined population of connectors. Inferences from the results of this experiment are applicable to the population of connectors represented by the five connectors tested. The four angles at which the connectors were pulled apart (0°, 2°, 4° and 6°) were not random selections from a population of angles of pull. These values were selected at equal intervals to determine the effect of angle pull between 0° to 6°. Thus, the angle of pull is a fixed factor, rather than a random one.

Interpretation of the Analysis

As seen in Table I, the average force required to separate connectors of this type is 43.6 pounds. However, this value is nominal because it changes depending on the particular connector used, and it is influenced by the inability of the testing machine to exactly reproduce a given result. However, from the angle of pull, F-ratio, in the analysis of variance (Table II), one may say that this average force is not significantly influenced by the angle at which a connector is pulled apart (up to 6°).

Comparing the values of the computed mean squares with the expected mean squares found mathematically (see Table II), one may find the following estimates of variance components:

$\hat{\delta}^2$ = estimate of error variation associated with the testing machine = $3.96 \approx 4.0$

$\hat{\sigma}_{AC}^2$ = estimate of error variation introduced by the fact that an increase in the angle of pull does not affect the connectors similarly

$$= \frac{37.92 - 3.96}{5} = 6.79 \approx 6.8$$

$\hat{\sigma}_{C}^2$ = estimate of error variation associated with the fact that the connectors are not alike

$$= \frac{308.71 - 3.96}{20} \approx 15.2$$

Utilization of the Above Information for Further Experimentation

The connectors being evaluated were to undergo vibration and shock tests immediately after the test described above, and the effect of pull angle would be assessed after exposure to these environments. Before subjecting the connectors to the next phase of the program it became necessary to determine which of the two methods shown below would be more economical, without substantially lowering the precision of the experiment: (1) decreasing the required number of connectors submitted to environmental testing, or (2) reducing the number of times each connector is tested in the testing machine.

Either one of the above alternatives amounts to a "reduction in the sample size" and would result in a reduction in the precision* of the experiment.

The method for minimizing the expense of further experimentation consisted of a mathematical analysis of the precision, or error, function and of a function expressing cost. The error function was minimized by the procedure of Lagrange Multipliers, subject to the restrictions imposed by the cost function. The method, which is shown in detail in Part IV of the Appendix, essentially yields the number of connectors and tests per connector in order to achieve a minimum error, for a specified reduction in cost.

For the values of the problem at hand, a minimum error is accomplished with a reduction in cost of $150, if during the destructive phase of the program three connectors are measured once for every angle of pull.

The example shown here is an oversimplification of a more complex cost function which could be constructed to encompass all other possible causes of expenditure.

Conclusions

The application of a mixed model factorial experiment to the solution of a practical engineering problem is described in this article. Estimates of variability were obtained by a statistical evaluation of the results from the first phase of the experimental program by using analysis of variance methods.

A method yielding a high degree of precision at a maximum economy was recommended for the second (destructive) phase of the program, based on the statistical evaluation of results from the first phase.

The technique described in this article is applied to an experimental program concerning tests on electrical connectors in the missile industry. This method may be applied to many other problems in engineering development and production, particularly where the articles produced or developed are expensive and of nonuniform properties.

Appendix

I. Computations

The total sum of squares represents the total variability in Table I:

$$TSS = (46.5)^2 + (39.0)^2 + \ldots + (59.0)^2 + (61.0)^2 - CT = 2281$$

where

$$CT = \frac{(46.5 + 39.0 + \ldots + 59.0 + 61.0)^2}{100}$$

The sum of squares of the angle of pull (SSA) was found as follows:

$$SSA = \frac{(1048.5)^2 + (1059.0)^2 + 1095.5)^2 + 1157.5)^2}{25} - CT = 290.79$$

where 1048.5 = total of all measurements taken at an angle of pull of 0°

1059.0 = total of all measurements taken at an angle of pull of 2°

1095.5 = total of all measurements taken at an angle of pull of 4°

1157.5 = total of all measurements taken at an angle of pull of 6°

*By precision it is meant the reciprocal of $\hat{\sigma}^2_{\bar{Y}_{i..}}$, the variance of the angle of pull mean. The formula for the variance of pull angle mean and its derivation is shown in the appendix, Part III.

The sum of squares between connectors was found as follows:

$$SSC = \frac{(878.0)^2+(874.0)^2+(842.5)^2+(774.5)^2+(991.5)^2}{20} - CT = 1234.83$$

where

878.0 = total of measurements taken using Connector No. 1,
874.0 = total of measurements taken using Connector No. 2,
842.5 = total of measurements taken using Connector No. 3, etc.

The sum of squares of interaction of connectors by angles was found as follows:

$$SS(A \times C) = \frac{(226.5)^2 + (211.0)^2 + (198.0)^2 + \ldots + (239.5)^2 + (189.5)^2 + (282.0)^2}{5} - CT - SSA - SSC = 455.03$$

where

226.5, 211.0, 198.0, etc., are the totals of each of the 20 angle-connector combinations used.

Finally,
The sum of squares of trials is found by adding the internal variability for each connector-angle combination; i.e.,

$$(46.5)^2 + (43.0)^2 + (46.5)^2 + (44.0)^2 + (46.5)^2 - \frac{(46.5 + 43.0 + 46.5 + 44.0 + 46.5)^2}{5}$$

$$+(39.0)^2 + (42.0)^2 + (44.0)^2 + (44.0)^2 + (42.0)^2 - \frac{(39.0 + 42.0 + 44.0 + 44.0 + 42.0)^2}{5}$$

$$+ (37.5)^2 + (40.0)^2 + (41.5)^2 + (40.0)^2 + (39.0)^2 - \frac{(37.5 + 40.0 + 41.5 + 40.0 + 39.0)^2}{5} + \ldots$$

$$+ (35.0)^2 + (37.0)^2 + (38.0)^2 + (39.5)^2 + (40.0)^2 - \frac{(35.0 + 37.0 + 38.0 + 39.5 + 40.0)^2}{5}$$

$$+ (52.0)^2 + (53.0)^2 + (57.0)^2 + (59.0)^2 + (61.0)^2 - \frac{(52.0 + 53.0 + 57.0 + 59.0 + 61.0)^2}{5} = 316.5$$

Note that the sum of squares of the various sources of variation equals the total sum of squares obtained previously.

The mean squares in Table II are obtained by dividing the degrees of freedom (number of independent comparisons) into the sum of squares. The size of the mean squares reveals the relative importance of each source of variation.

The F-ratios are ratios among the various mean squares as indicated by the expected, or average value, of these mean squares.

II. Derivation of the Expected Mean Squares

As stated before, the model used is

$$y_{ijk} = m + a_i + c_j + (ac)_{ij} + e_{ijk} \qquad (1)$$

where

y_{ijk} is the observation corresponding to the i th angle, j th connector, and k th test trial.

$i = 1, 2, 3 \ldots r$ (r = number of angles of pull = 4)
$j = 1, 2, 3 \ldots s$ (s = number of connectors tested = 5)
$k = 1, 2, 3 \ldots t$ (t = number of test trials for each connector = 5).

a_i represents the effect of the i th angle of pull, and without loss of generality one can write

$$\sum_{i=1}^{r} a_i = 0 \qquad (2)$$

The c_j's, $(ac)_{ij}$'s, and e_{ijk}'s are assumed to be normally and independently distributed random variables with mean zero and variances σ^2_C, σ^2_{AC}, and σ^2 respectively i.e.,*

$$E(c_j) = E(ac)_{ij} = E(e_{ijk}) = 0$$

$$\sigma^2_C = E[c_j - E(c_j)]^2$$

$$\sigma^2_{AC} = E[(ac)_{ij} - E(ac)_{ij}]^2$$

and

$$\sigma^2 = E[e_{ijk} - E(e_{ijk})]^2$$

Since all $(ac)_{ij}$ interaction effects for a given connector (fixed j) are contained in the sample, it is reasonable to assume

$$\sum_{i=1}^{r} (ac)_{ij} = 0 \qquad (3)$$

To find the expected mean squares in the analysis of variance of Table II one must first substitute the value of each experimental observation (y_{ijk}) in terms of the model (Eq. 1) into the formula for the appropriate estimate of the mean square.

Thus, the estimate of the mean square for angles of pull is

$$MSA = \frac{1}{r-1} \sum_{i=1}^{r} \sum_{j=1}^{s} \sum_{k=1}^{t} (y_{i\cdot\cdot} - y_{\cdots})^2 = \frac{1}{r-1}\left[\sum_{i=1}^{r} \frac{\left(\sum_{j=1}^{s} \sum_{k=1}^{t} y_{ijk}\right)^2}{st} - \frac{\left(\sum_{i=1}^{r} \sum_{j=1}^{s} \sum_{k=1}^{t} y_{ijk}\right)^2}{rst}\right] \qquad (4)$$

The conventional notation of replacing a subscript

*The symbol E represents the expected value, or averaging value, of a random variable x which has a continuous probability distribution $f(x)$. The expected value of x is by definition

$$E(x) = \int_{-\infty}^{+\infty} x f(x)\, dx$$

The variance of x is defined as

$$\sigma^2(x) = E[x - E(x)]^2$$

for a dot when an average has been taken is used. Thus,

$$c_{\cdot} = \frac{1}{s}\sum_{j=1}^{s} c_j$$

One may note $a_{\cdot} = 0$ and $a_{\cdot j} = 0$ by the assumptions stated in (2) and (3).

Replacing the y_{ijk} values in terms of the model, the numerator of (4) becomes

$$\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}(y_{i\cdot\cdot} - y_{\cdot\cdot\cdot})^2$$

$$= \sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}[(a_i - a_{\cdot}) + (ac)_{i\cdot} - (ac)_{\cdot\cdot} + (e_{i\cdot\cdot} - e_{\cdot\cdot\cdot})]^2$$

Squaring this expression one has

$$\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}(y_{i\cdot\cdot} - y_{\cdot\cdot\cdot})^2$$

$$= \sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}\Big\{a_i^2 + [(ac)_{i\cdot} - (ac)_{\cdot\cdot}]^2 + (e_{i\cdot\cdot} - e_{\cdot\cdot\cdot})^2 + 2\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t} a_i[(ac)_{i\cdot} - (ac)_{\cdot\cdot}] + \text{twice the other cross products}\Big\}$$

The expected value of the mean square is, therefore,

$$E[MSA) = E\left\{\frac{1}{(r-1)}\left[\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}(y_{i\cdot\cdot} - y_{\cdot\cdot\cdot})^2\right]\right\}$$

$$= \frac{st}{r-1}\sum_{i}^{r} a_i^2 + \frac{t}{r-1}\sum_{i=1}^{r}\sum_{j=1}^{s} E[(ac)_{i\cdot} - (ac)_{\cdot\cdot}]^2 + \frac{1}{r-1}\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t} E[e_{i\cdot\cdot} - e_{\cdot\cdot\cdot}]^2$$

The expected values of the cross product terms are zero because of the assumption of independence of errors.

By definition of σ^2_{AC} and σ^2, it follows that

$$E[(ac)_{i\cdot} - (ac)_{ij}]^2 = \sigma^2_{AC}/s$$

and

$$E[e_{i\cdot\cdot} - E(e_{ijk})]^2 = \sigma^2/st$$

using the following identities

$$\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}[(ac)_{i\cdot} - (ac)_{\cdot\cdot}]^2$$

$$= \sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}[(ac)_{i\cdot} - E(ac)_{ij}]^2 - \sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}[(ac)_{\cdot\cdot} - E(ac)_{ij}]^2$$

and

$$\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}(e_{i\cdot\cdot} - e_{\cdot\cdot\cdot})^2$$

$$= \sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}[e_{i\cdot\cdot} - E(e_{ijk})]^2 - \sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}[e_{\cdot\cdot\cdot} - E(e_{ijk})]^2$$

One finds

$$E[MSA] = st\sum_{i=1}^{r}\frac{a_i^2}{r-1} + t\,\sigma^2_{AC} + \sigma^2$$

In a similar fashion, the expected values of mean squares of connectors, connector by angle interaction, and error are:

$$E[MSC] = E\left[\frac{1}{s-1}\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}(y_{\cdot j\cdot} - y_{\cdot\cdot\cdot})^2\right] = rt\,\sigma^2_C + \sigma^2$$

$$E[MSA \times C] = E\left[\frac{1}{(r-1)(s-1)}\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}(y_{ijk} - y_{i\cdot\cdot}) - (y_{\cdot j\cdot} - y_{\cdot\cdot\cdot})\right] = t\,\sigma^2_{AC} + \sigma^2$$

and

$$E[MSE] = E\left[\frac{1}{(t-1)rs}\sum_{i=1}^{r}\sum_{j=1}^{s}\sum_{k=1}^{t}(y_{ijk} - y_{ij\cdot})^2\right] = \frac{\sigma^2(rst - rs)}{(t-1)rs} = \sigma^2$$

III. Variance of a Treatment Mean

The variance of $y_{i\cdot\cdot}$ is by definition

$$\sigma^2_{y_{i\cdot\cdot}} = E[y_{i\cdot\cdot} - E(y_{i\cdot\cdot})]^2$$

In terms of the model this is

$$\sigma^2_{y_{i\cdot\cdot}} = E[m + a_i + c_{\cdot} + (ac)_{i\cdot} + e_{i\cdot\cdot} - m - a_i]^2$$

$$= \frac{\sigma^2_C}{s} + \frac{\sigma^2_{AC}}{s} + \frac{\sigma^2}{st}$$

$$= \frac{t(\sigma^2_C + \sigma^2_{AC}) + \sigma^2}{st}$$

This quantity may be estimated from the sample by

$$\hat{\sigma}^2_{\bar{y}_{i..}} = \frac{t(\hat{\sigma}^2_C + \hat{\sigma}^2_{AC}) + \hat{\sigma}^2}{st}$$

Since

$$\hat{\sigma}^2_{AC} = 6.8$$

$$\hat{\sigma}^2_C = 15.2$$

and

$$\hat{\sigma}^2 = 4.0$$

it follows that

$$\hat{\sigma}^2_{\bar{y}_{i..}} = \frac{22.0t + 4.0}{st}$$

IV. Cost Minimization

The cost of testing "s" connectors and measuring the separation on each "t" times is

$$C = K_1 s + 4K_2 st,$$

where

K_1 is the cost of a connector,

K_2 is the cost of testing a connector one time, and

4 is the number of angles of pull measured.

The error function, i.e., variance of angle of pull mean function, was derived in part III of the appendix and is as follows:

$$\hat{\sigma}^2_{\bar{y}_{i..}} = V = \frac{22t + 4}{st}$$

This function is minimized subject to the restriction imposed by the cost function

$$C = K_1 s + 4K_2 st$$

A particular cost reduction $C_1 - C_0$ is specified, where C_0 is the cost of the first part of the program (i.e. the value of C for $s = 5$ and $t = 5$), and C_1 the cost for the second part.

The error function is minimized by the method of Lagrange Multipliers. According to this method, the values of s and t (called s_0 and t_0 respectively) which minimize the error function are the solutions to the following system of linear equations with three unknowns: s, t, and λ, the Lagrange Multiplier.

$$\frac{\partial V}{\partial s} + \lambda\left(\frac{\partial C_1}{\partial s}\right) = 0$$

$$\frac{\partial V}{\partial t} + \lambda\left(\frac{\partial C_1}{\partial t}\right) = 0$$

$$C_1 - K_1 s - 4K_2 st = 0$$

Solving for λ from the first two equations one finds

$$\lambda = \frac{4 + 22t}{s^2 t} \cdot \frac{1}{K_1 + 4K_2 t} = \frac{1}{K_2 s^2 t^2}$$

From the above expression one has

$$t = t_0 = \sqrt{\frac{K_1}{22K_2}}$$

and

$$s = s_0 = \frac{C_1}{K_1 + 4\sqrt{\frac{K_1 K_2}{22}}}$$

These values yield a minimum because the necessary and sufficient conditions for a minimum are satisfied, which are:

$$\frac{\partial}{\partial s}\left(\frac{\partial V}{\partial s}\right) = \frac{44t + 8}{s^3 t} > 0$$

$$\frac{\partial}{\partial t}\left(\frac{\partial V}{\partial t}\right) = \frac{8}{st^3} > 0$$

and

$$\left[\frac{\partial}{\partial t}\left(\frac{\partial V}{\partial s}\right)\right]^2 - \left[\frac{\partial}{\partial s}\left(\frac{\partial V}{\partial s}\right)\right]\left[\frac{\partial}{\partial t}\left(\frac{\partial V}{\partial t}\right)\right] = -\frac{(352t + 48)}{s^4 t^4} < 0$$

For the problem at hand,

$$K_1 = \$30, \quad K_2 = \$1$$

The initial cost of the program C_0 is

$$C_0 = 30(5) + 4(1)(5)(5) = \$250$$

If one wishes to cut down expenses by $C_0 - C_1 = \$150$, the number of connectors and tests per connector required for achieving minimum error are

$$t_0 = \sqrt{\frac{30}{22}} = 1.17 \approx 1$$

$$s_0 = \frac{100}{30 + 4(1)(1.17)} = 2.88 \approx 3$$

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The Experiment, The Design, The Analysis

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MANY TIMES in my experience and in reading experimental results of others, I have been concerned about the failure to distinguish between the experiment, the design, and the analysis.

Quite a bit has been written about methods of analysis such as analysis of variance, multiple regression, etc., and considerable space has been devoted to the steps to be taken in designing an experiment. But little has been said about the experiment on the one hand and the design used to carry out the experiment on the other. The line which separates the experiment from its design is often fuzzy, but I believe it may be helpful to an experimenter to define this line a bit more carefully in order to achieve better results for the money expended.

The following outline lists some of the items which I believe should be put under the three classifications cited in the title of this paper:

1. The Experiment
   - Statement of the problem to be solved.
   - Choice of the dependent variable or variables to be studied.
   - Selection of the factors to be varied in the experiment which may affect the response variable of interest. These factors may be quantitative or qualitative.
   - Choice of the levels of each factor and whether these levels are to be set at fixed values or chosen at random, i.e. do we have a fixed, random or mixed model.

2. The Design
   - The number of observations to be taken. This will depend upon the factor levels chosen and the number of replications believed necessary for a discriminating experiment in the light of the risks the experimenter will tolerate.
   - The order in which the experiment is to be performed.
   - The method of randomization to be used.
   - The mathematical model which describes the experiment.

3. The Analysis
   - The interpretation of the numerical results in terms meaningful to the experimenter.

In order to clarify the three classifications above, three examples will be discussed which should help to point out the distinction between the experiment and its design. In each case the analysis will be indicated but the details will be omitted as many texts and articles deal with the techniques of analyzing data.

Example 1—Electric-Discharge Machinery

A study was recently made at Purdue of the effect of electrode shape on the metal-removal rate when these electrodes are used to "cut" holes in half-inch Stentor tool steel by electric-discharge. While consulting with the experimenter, it was decided that five fixed electrode shapes were to be studied and the response variable of interest was metal-removal rate in cu. in. per minute. We have here the essential elements of the experiment and one might hastily say, "Oh, yes, a single factor experiment at five fixed levels, so we'll run a one-way analysis of variance with several observations at each of the five levels. The model assumed would be

$$X_{ij} = \mu + E_i + \varepsilon_{j(i)}$$

where μ is a common effect, E_i represents the effect of the electrode ($= 1, 2, \ldots 5$) and $\varepsilon_{j(i)}$ represents the random error with $j = 1, 2, \ldots n$ for n observations per electrode. Go ahead and run the experiment and bring me your results and I'll help you on the analysis of variance"

Here the essential step of "design" has been practically omitted. If we question our experimenter further by asking "Just how are you going to run your experiment?" we will uncover some interesting design problems. He tells us that he plans to make several "cuts" using each electrode and after consideration of the risks involved, he says $n = 5$, or five replications, using each type should be adequate. Now, "What about the samples of steel which are to be cut? Are they all uniform or could there perhaps be differences in metal-removal rate between the samples even if the same electrode were used?" He admits there could be such differences and plans to use five, $2'' \times 8''$ samples for his experiment. The question now arises as to the order in which cuts will

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be made with the five electrodes on the five steel samples. Several possible orders might be examined. The first would obviously be bad where the 1st sample was used for all five "cuts" with electrode A, the next sample for all five "cuts" with electrode B, etc., as in Table I.

Here possible differences between samples are completely confounded with electrode types and one could not tell whether differences in metal-removal rate were due to the electrode types or the sample of steel used. Our experimenter may immediately say "randomize" and he is aware that this should average out any differences due to steel samples when studying the electrode type effect on removal rate. When randomized, the design might be laid out as in Table II.

This design is called a completely randomized design and we could say that the experiment is a single-factor experiment, and it is carried out in a "completely randomized" manner. The model cited above would then apply with n = 5 and the analysis would proceed as follows:

Source of Variation	d.f.	S.S.
Between electrodes	4	
Within electrodes	20	
Total	24	

A close examination of the above layout shows that any variation within a given electrode will be inflated by sample differences if they exist, and it is

Table I

Sample	Position 1	2	3	4	5
1	A	A	A	A	A
2	B	B	B	B	B
3	C	C	C	C	C
4	D	D	D	D	D
5	E	E	E	E	E

Table II

Sample	Position 1	2	3	4	5
1	A	E	A	C	D
2	B	A	E	E	C
3	C	D	A	B	E
4	C	B	C	B	D
5	D	A	B	D	E

Table III

Sample	Position 1	2	3	4	5
1	B	D	E	A	C
2	A	C	B	D	E
3	E	C	B	A	D
4	C	D	A	B	E
5	C	A	B	E	D

Table IV

Sample	Position 1	2	3	4	5
1	A	B	C	D	E
2	E	A	B	C	D
3	D	E	A	B	C
4	C	D	E	A	B
5	B	C	D	E	A

Table V

Type of Cut	Bevel 1 Tool 1	Bevel 1 Type 2	Bevel 2 Tool 1	Bevel 2 Type 2
1	—	1	—	3
	—	—	—	4
	—	—	—	—
	—	—	—	—
2	2	—	5	—
	—	—	—	—
	—	—	—	—
	—	—	—	—

one of the objectives of experimental design to reduce the error variation. This could be accomplished by restricting the randomization above so that each electrode is used just once on each sample. Such a design is called a "randomized block" design where the effect of blocks (in this case, samples) could be assessed and removed from the error term. This might result in a more precise test of differences between electrode types as all five types are compared in each sample. One could still randomize the order of the electrodes used along each strip and might then get the layout shown in Table III.

The model would now be:

$$X_{ij} = \mu + E_i + S_j + \varepsilon_{ij}$$

where the S_j term represents the sample effect on the metal removal rate. The analysis for this model would be:

Source	d.f.	S.S.
Bet. Electrodes	4	
Bet Strips	4	
Error	16	
Total	24	

It is, of course, true that the number of degrees of freedom for error has been reduced in this randomized block design but the hope is that we have a better error term than when it was confounded with the sample effect. It is to be noted once again that this is still a one-factor experiment but performed now using a randomized block design. This type of design represents a restriction on the complete randomization so that each block (sample) contains all five electrode types and the order within the block is randomized. Such a design assumes no interaction between samples and electrode types. For this problem, another big advantage of the randomized block design is that the electrodes wear considerably after each "cut" and the effect of this wear would now show up as a "between samples" variation. We would still get a good comparison between electrodes at each stage in the sampling.

Pushing the point still further, the question was raised about uniformity along the sample. Could there be difference in metal-removal rate from one end of the sample to the other? It was agreed that this might occur and so the position along the sample could introduce another source of variation. If it is

worthwhile to remove this from the error variation, a "Latin Square" design could be used which requires that each electrode type be used once and only once on each sample and in each position along the sample. One layout would be that shown in Table IV.

The corresponding model would be:

$$X_{ijk} = \mu + E_i + S_j + P_k + \varepsilon_{ijk}$$

where P_k represents the position effect. The analysis of variance would be:

Source	d.f.	S.S.
Bet. Electrodes	4	
Bet. Samples	4	
Bet. Positions	4	
Error	8	
Total	20	

Here we have further restrictions on the randomization but the particular Latin Square used can be drawn at random from tables of Latin Squares. Here again no interaction is assumed and although there are only eight degrees of freedom in the error term, it is seen that this error term has the position effect removed from it.

The problem represents a one-factor experiment but at least three different designs (completely randomized, randomized block, and Latin Square) might be used to carry it out, when we concern ourselves with the actual order in which the experiment is to be run. The Latin Square design was actually used for this problem.

Example 2—Power Consumption With Ceramic Tools

An experiment was to be designed to determine the effects of ceramic tool types, tool edge bevel, and types of cut on the power requirements when cutting metal with ceramic tools. Here the experiment consisted of three factors: tool type, bevel, and type of cut, each to be studied at two fixed levels. For each of the eight combinations power consumption was to be measured on several cuts (n). This is quite obviously a 2^3 factorial experiment with n observations per cell. But what about the design? What order is to be followed in running these eight conditions n times each?

After considering risks, etc., it was decided to run four replications of each of the eight conditions and

Table VI

Source	d.f.	S.S.	M.S.	E.M.S.
Temperature	2			$\sigma^2 + 12\sigma^2_{ST} + 60\sigma^2_T$
Humidity	2			$\sigma^2 + 12\sigma^2_{SH} + 60\sigma^2_H$
T × H	4			$\sigma^2 + 4\sigma^2_{STH} + 20\sigma^2_{TH}$
Strips	4			$\sigma^2 + 36\sigma^2_S$
S × T	8			$\sigma^2 + 12\sigma^2_{ST}$
S × H	8			$\sigma^2 + 12\sigma^2_{SH}$
S × T × H	16			$\sigma^2 + 4\sigma^2_{STH}$
Error	135			σ^2
Total	179			

the experimenter agreed that he could completely randomize the 32 runs. The data layout is shown in Table V.

The randomization was carried out using a penny, a nickel and a dime to represent tool type, bevel, and type of cut. Heads on the coin represented the 2nd level of the factor; tails the 1st level. Thus, if the 1st toss came up: THT it would mean tool type 1, bevel 2, and type of cut 1. This is shown as a number 1 in the body of the table. The 2nd toss was TTH as shown in the table. This is continued until all 32 conditions have been met, the only restriction being that just four replications are made in each cell. The model would be:

$$X_{ijkm} = \mu + T_i + B_j + TB_{ij} + C_k + TC_{ik} + BC_{jk} + TCB_{ijk} + \varepsilon_{m(ijk)}$$

where T_i represents tool type, B_j bevel, C_k type of cut, and the other terms are interactions. Here i, j, and k run from 1 to 2 and m from 1 to 4. The analysis would be:

Source	d.f.	S.S.
Tool Type	1	
Bevel	1	
T × B	1	
Type of cut	1	
T × C	1	
B × C	1	
T × B × C	1	
Error	24	
Total	31	

As this is a fixed model all effects will be tested against the error term by the F test.

Although a completely randomized design was possible in this problem, there are often situations where it is most impractical to keep changing from one cell to another in a random fashion. For example, when one tool type with bevel 1 is in the press it would be wise to run both types of cut — continuous and interrupted — on several replications. This would restrict the randomization and a different design would be necessary. Again, it may only be possible to run 16 cuts per day and the next 16 on the following day, and if there are any day-to-day fluctuations in power consumption, we would have to design the experiment to avoid confounding any important effects with days. Often such restrictions lead to confounding in blocks, whereas, a practical restriction on the number of tests that could be run might lead to a fractional replication of the experiment. Such techniques are described in texts on design of experiments[2] and represent restrictions on randomization or on the amount of experimentation that can be done. It is not safe to assume that because data are laid out as in the table above they are really collected in a completely random order.

Example 3—Pull-off Force on Taped Boxes

Engineers wished to study the effect of environmental conditions on the force necessary to pull some small boxes away from a glued tape. Several tapes were available, each with some 75 boxes already glued on them. A spring balance was to be used to pull these boxes from the tape at right angles to the tape. The experimenter was concerned about the effect of temperature (hot, room, cold) and humidity (50, 70, and 90 percent) on the force necessary to pull off the box. It was also noted that there might be differences in pull-off force between strips that hold the boxes. It was agreed to choose five strips at random from the strips available and subject several boxes from each strip to the nine environmental conditions and analyze the results for temperature effect, humidity effect, strip effect and all the associated interactions.

A consultant might say we have here a 3 × 3 × 5 factorial experiment with n replications within cells. The three levels of temperature and humidity are fixed, while the five strips are chosen at random from

Table VII

	Chamber								
	1 T-cold H-50%	2 T-cold H-70%	3 T-cold H-90%	4 T-room H-50%	5 T-room H-70%	6 T-room H-90%	7 T-hot H-50%	8 T-hot H-70%	9 T-hot H-90%
Rep I	Strip 1<*	Strip 1							
	2	2							
	3	*							
	4	*							
	5<	5							

*< means boxes 1 and 2 on that strip etc.
Replications II, III and IV same as above.

many strips giving a mixed model experiment. After agreement on the number of replications per cell (here n = 4) a model is set up and the analysis indicated as in Table VI.

$$X_{ijkm} = \mu + T_i + H_j + TH_{ij} + S_k + ST_{ik} + SH_{jk} + STH_{ijk} + \varepsilon_{m(ijk)}$$

$i = 1, 2, 3;\ j = 1, 2, 3;\ k = 1, \ldots 5;\ m = 1, \ldots 4$

The expected mean squares (EMS) are listed here as this is a mixed model — two fixed factors and one random factor. The previous two problems involved only fixed effects, all of which are tested against the error mean square. Here the EMS column indicates the proper tests to be made on each term in our model.[3]

The above discussion may seem very plausible until one very embarrassing question is raised: "In what order are you going to run these 180 experiments?" The above model assumes a complete randomization which would be most impractical here. If complete randomization was used, a strip might be selected at random, then a box from the tape, and humidity selected also at random. The very next run would most likely involve another combination of temperature and humidity. The experimenter is sure that when he gets his environmental chamber up to the required temperature and humidity, he wants to make tests on boxes from all five strips before resetting for another temperature — humidity combination. Further discussion reveals that he is willing to make a complete re-run of the experimental conditions at some later date if this is necessary. These very practical considerations would definitely restrict the randomization and lead us to use a split-plot design.

If the nine combinations of temperature and humidity are considered as nine chambers and we allow four replications of the whole experiment, the layout might by that in Table VII.

In such a layout, the chambers by Reps are called the "whole plots" and within each chamber-rep combination the experiment is split into five strips with, say two boxes per strip (here the four boxes would not add much to the experiment and we could use only one.) This part of the experiment is called "split plot." A model for this experiment follows in a vertical column along with the analysis layout. (See Table VIII.)

The point of this design is that the restriction on the randomization due to physical necessity means that a different error term is used for tests on the whole plot than is used for testing in the split plot. From the EMS column, we note that the main factors of interest: temperature and humidity, have no exact test, but if we can assume that σ^2_{RT}, σ^2_{RH}, and σ^2_{RTH} are all zero, the temperature effect can be tested against the strip-temperature interaction term and similarly for humidity and TH interaction. The above design also provides tests for σ^2_{RT}, σ^2_{RH} and σ^2_{RTH} which may be carried out prior to making the assumption that they are negligible. It should also be pointed out that running four boxes from a strip rather than the two used above would only increase the degree of freedom on the error term $\varepsilon_{q(ijkm)}$ which is used only to test high order interactions with random factors involved. It is far more important here to replicate the whole experiment several times than to repeat many tests on boxes within the same set-up.

It is not the purpose of this paper to go into details of analysis of these[4] or other designs but only to point out the importance of the design phase in setting up experiments. I believe it would always be wise to raise questions as to what order the experiment is to follow and to distinguish clearly between the experiment, the design and the analysis.

Table VIII

Model	d.f.	E.M.S.
R_i (reps.)	3	$\sigma^2 + 18\sigma^2_{SR} + 90\sigma^2_R$
T_j (temp.)	2	$\sigma^2 + 6\sigma^2_{SRT} + 24\sigma^2_{RT} + 30\sigma^2_{RT} + 120\sigma^2_T$
RT_{ij}	6	$\sigma^2 + 6\sigma^2_{SRT} + 30\sigma^2_{RT}$
H_k (hum.)	2	$\sigma^2 + 6\sigma^2_{SRH} + 24\sigma^2_{RH} + 30\sigma^2_{RH} + 120\sigma^2_H$
RH_{ik}	6	$\sigma^2 + 6\sigma^2_{SRH} + 30\sigma^2_{RH}$
TH_{jk}	4	$\sigma^2 + 2\sigma^2_{STRH} + 8\sigma^2_{STH} + 10\sigma^2_{RTH} + 40\sigma^2_{TH}$
RTH_{ijk}	12	$\sigma^2 + 2\sigma^2_{STRH} + 10\sigma^2_{RTH}$
Subtotal	35	
S_m (strips)	4	$\sigma^2 + 18\sigma^2_{SR} + 72\sigma^2_S$
SR_{im}	12	$\sigma^2 + 18\sigma^2_{SR}$
ST_{jm}	8	$\sigma^2 + 6\sigma^2_{SRT} + 24\sigma^2_{ST}$
SRT_{ijm}	24	$\sigma^2 + 6\sigma^2_{SRT}$
SH_{km}	8	$\sigma^2 + 6\sigma^2_{SRH} + 24\sigma^2_{SH}$
SRH_{ikm}	24	$\sigma^2 + 6\sigma^2_{SRH}$
STH_{jkm}	16	$\sigma^2 + 2\sigma^2_{STRH} + 8\sigma^2_{STH}$
$STRH_{ijkm}$	48	$\sigma^2 + 2\sigma^2_{STRH}$
Subtotal	144	
$\varepsilon_{q(ijkm)}$	180	σ^2
Total	359	

References

(1) McDowell, R. W. and Lascoe, O. D. "What's the Best Electrode Shape for Removing Metal", *American Machinist*, Apr. 20, 1959.

(2) Davies, O. L., *Design and Analysis of Industrial Experiments*, Hafner, 1954.

(3) Hicks, C. R., "Fundamentals of Analysis of Variance", Parts I, II and III, *Industrial Quality Control*, August, September and October, 1956.

(4) Cochran, W. and Cox, G., *Experimental Design*, Wiley, 1950, 1st edition (pg. 218 for Split Plot Design).

A Six-Step

Quality Control Program

HARLEY WEHRWEIN

Continental Machines, Inc., Savage, Minn.

Continental Machines manufactures DoALL machine tools and gage blocks, and is, therefore, faced with the most exacting quality requirements to be found in a competitive manufacturing situation. In order to exercise the control that this necessitates, the following facts about our overall situation must be known at all times: What is the present quality level? How is that level being controlled? And, how much control is needed to maintain or improve that level?

Six Steps for Total Quality Control

We have met this requirement by setting up a six-step system directed at eliminating scrap before it starts. Unlike the "They shall not pass" thinking, we have made quality control a positive force for the constant improvement of product quality with a lowering of manufacturing cost. The six steps are as follows:

1. Control the "standard inch"
2. Establish machine and process parameters
3. Record complete and reliable data
4. Provide fixed standards
5. Develop QC professionalism
6. Communicate QC at all levels

To control the "standard inch" means much more than the vigilant and careful use of inspection instruments. It is instead only through constant gage supervision that accuracy is built into the product. Each gage is marked for ready identification, and a permanent record established for each. This completely records its acquisition, use and calibration history. It is the gage inspector's responsibility to use this record to project anticipated gage life, so that replacements can be made before scrap starts.

Figure 2 — To eliminate errors from transfer of measurement, gage blocks are used directly in the manufacturing operations. In this example the turret lathe operator is using gage blocks to locate a shoulder in a short run production job.

To provide the best product quality at the lowest cost requires a balance of design, tooling and process control. This balance is unlikely if the contribution of each factor is not known. Therefore, it is essential that all machine and process parameters be established. All sources of deviations must be evaluated and subjected to preventive controls.

Quality Control Cards

Adequate records transform haphazard, costly and ineffective quality control into a vital and efficient management tool. We feel we have achieved this objective by use of a quality control card that not only correlates all pertinent information, but also stores these data for orderly recall and analysis, using a keysort system.

A card is started for each production job at the time that the shop order is initiated. As the

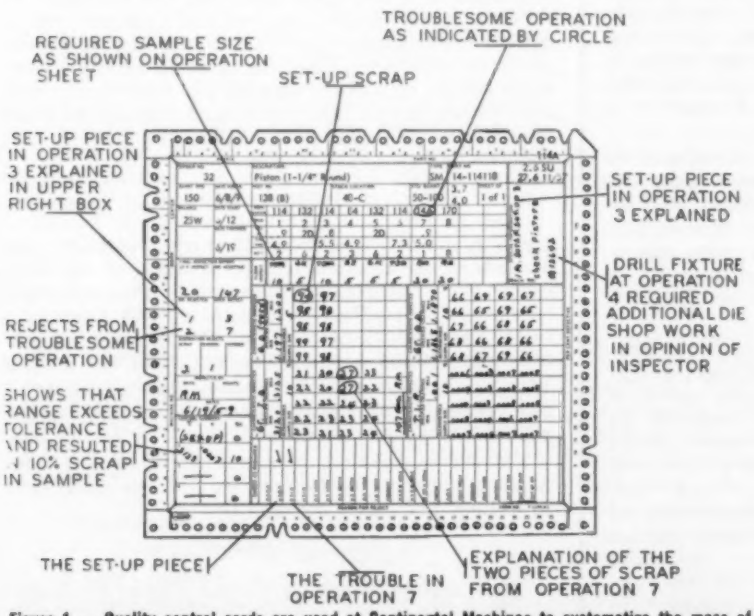
REQUIRED SAMPLE SIZE AS SHOWN ON OPERATION SHEET
TROUBLESOME OPERATION AS INDICATED BY CIRCLE
SET-UP SCRAP
SET-UP PIECE IN OPERATION 3 EXPLAINED IN UPPER RIGHT BOX
SET-UP PIECE IN OPERATION 3 EXPLAINED
DRILL FIXTURE AT OPERATION 4 REQUIRED ADDITIONAL DIE SHOP WORK IN OPINION OF INSPECTOR
REJECTS FROM TROUBLESOME OPERATION
SHOWS THAT RANGE EXCEEDS TOLERANCE AND RESULTED IN 10% SCRAP IN SAMPLE
THE SET-UP PIECE
THE TROUBLE IN OPERATION 7
EXPLANATION OF THE TWO PIECES OF SCRAP FROM OPERATION 7

Figure 1 — Quality control cards are used at Continental Machines to systematize the mass of inspection data into an efficient tool for constant product and methods improvement.

ASQC LCS Codes 341;342;720:80;70:435

job proceeds through the shop, an inspector at each work center notes the sample size and number of rejects, if any. Spaces are provided for an explanation of these rejects. Four sections are used for detailed recording of critical dimensions. Because we do not use go and no-go gages (except in rare cases), actual dimensions are recorded. The control summary section then recapitulates the critical dimension data. The punched edges of the card are notched to identify the part, machine number, and work centers. Other notching shows the reason for reject and percent defective.

The quality control cards call attention to transient problems and provide the information needed to evaluate them. They are also systematically analyzed at regular periods to disclose trouble areas that might otherwise remain undetected. Specifically, the cards permit mechanizing the following quality control considerations:

1. Parts or assemblies that present particular problems
2. Percentage of defective parts in an order
3. Reasons for rejects or defective material
4. Quality of vendor furnished material
5. Operations that present particular problems
6. Percentage of defective parts for a given operation
7. Reasons for rejects from an operation
8. Machines that present particular problems
9. Percentage of defective parts for a given machine
10. Reasons for rejects from a machine
11. Troublesome inspection equipment and procedures
12. Data for determining proper sample size
13. Data concerning machine, tooling and method capabilities
14. Information relative to specifications or operation change

Emphasis on Fixed Standards

Quality control monitors all plant standards and pin-points the need for additional ones. But in this activity it is recognized that if a characteristic is not subject to measurement and numerical expression, it is not a standard but simply a personal opinion. Only those standards that are fixed have a place in a quality control program.

The adherence to fixed standards, not subject to personal judgement, removes the inspectors from the policeman role. They are basically auditors who by examination of the records can detect trends, appraise their importance, and then implement appropriate action. Obviously they are instrumental in cost reduction and efficiency improvement for the entire operation.

The prime objective of quality control is the prevention of defects. It must start with product design and end only when the product has been placed in the hands of a customer who remains satisfied. In accomplishing this, far more people influence quality than those in quality control. To these people we seek to emphasize the positive aspects of quality control. It is shown that the inspector is a valuable ally of the production man, and that his specialty makes everyone's job easier, more productive and more secure. This is an education project but one that pays off by giving real meaning to the "quality" in "quality control."

SAMPLING PLANS With Electronic

IRVING B. ALTMAN

Introduction

MILITARY SPECIFICATIONS for electronic parts (e.g., capacitors, resistors, relays) include increasingly quantitative reliability requirements, as well as life-test procedures required to demonstrate that these requirements have been satisfied. Because of the costliness of such testing to failure, it is necessary to utilize efficient sampling procedures based on valid statistical methods. MIL-S-19500B[1] on semiconductor devices (dated June 30, 1959) includes sampling plans for life testing necessary to assure various levels of reliability in terms of maximum allowable failure rates.

The purpose of this article is to provide quality control and reliability engineers with a basic understanding of (1) the exponential distribution underlying the life-test sampling plans, (2) the method of calculating the operating characteristic curves of the sampling plans when the life test is terminated at a pre-determined time, and (3) the effect of various maximum allowable failure rates, test times and acceptance numbers on the required sample sizes.

Exponential Distribution of Times to Failure

Let us assume that 1000 electronic parts were subjected to a life test, and the times to failure exhibited a constant failure rate of 10 percent per 1000 hours. Thus, within the first 1000 hours, 10 percent of the population of 1000 parts, or 100 units, would fail. Similarly, during the second thousand hours, 10 percent of the survivors, or 90 units, would fail. For succeeding 1000-hour intervals, the frequency of failures are computed in a similar manner. Fig. 1 depicts the resulting frequency distribution of times-to-failure of the hypothetical example having a constant failure rate of ten percent per 1000 hours. This distribution can be fitted by a mathematical function known as the exponential. The equation of this function is

$$K\varepsilon^{-t/\theta_0}$$

where K is a constant determined by multiplying the number of units tested (N) by the size of the class interval (h) and dividing the result by the mean time to failure (θ_0). The constant ε is well known in mathematics and equals 2.7183. The exponential distribution usually seen in the statistical life testing literature ($1/\theta_0\varepsilon^{-t/\theta_0}$) is used to describe the relative frequency distribution and is referred to as the probability density function.

For the exponential distribution, there is a relationship between the failure rate and the mean time to failure. The exact formula is:

$$\text{Failure rate} = 1 - \varepsilon^{-h/\theta_0}$$

A good approximation for small values of failure

ASQC LCS Codes 200;823:60;70:436

FOR DETERMINING COMPLIANCE

Parts Reliability Requirements

Office of the Assistant Secretary of Defense Supply and Logistics, Washington, D.C.

rate (less than ten percent per 1000 hours) is F.R. = h/θ_0. The latter formula is used rather extensively and personnel engaged in reliability often state that the failure rate is the reciprocal of the mean time to failure when assuming an exponential distribution. In the hypothetical example given above, it is easy to compute the exact mean time to failure for the ten percent per 1000 hour failure rate. Referring to a table of the exponential function (e.g., Table XV *Handbook of Mathematical Tables and Formulas* R. S. Burington, Handbook Publishers, Inc.), θ_0 is computed as 9488 hours. Using the approximate formula, the mean time to failure equals 10,000 hours.

Fig. 2. shows a graph of the reliability function of the hypothetical example of a constant failure rate of ten percent per 1000 hours. The reliability function — R(t) — is easily computed from the cumulative relative frequency distribution which is usually designated as F(t). The reliability function is computed from the formula

$$R(t) = 1 - F(t)$$

This curve provides the percent of the population or the probability of a component exceeding the various times-to-failure. For example, 81 percent of the population of components will exceed 2000 hours of life; 37 percent of the population will fail after the mean time to failure (9488 hours). In actuarial terms, the reliability curve provides the probability of a component surviving various life times.

Analysis of life-test data[2] for many electronic components and equipments has indicated that the exponential distribution provides a reasonably good fit to the data. However, it should not be assumed that this distribution is always appropriate. Examples have appeared in the literature[3] which illustrate the applicability of the normal distribution function for characterizing the life of certain electron tubes functioning in commercial airline navigation equipments and in military electronic equipments. Similarly, more complicated distribution functions such as the Γ and the Weibull[4] can approximate the data better in many instances. The failure rate of the normal distribution increases with time and is characteristic of a "wear-out" process. The failure rates of the Γ and Weibull distributions may be constant, increasing or decreasing, depending on the particular parameters selected for these functions. It should be noted that the exponential distribution is a special case of the more general Γ and Weibull distributions and exhibits a constant failure rate.

Sampling Plans for Life Testing Truncated at a Predetermined Time

In life and reliability testing of electronic components, it is convenient to subject the sample units to a test that simulates operating conditions for a fixed period of time (e.g., 500 hours) and, after elapse of the test period, to determine the number of units that have failed. Acceptance or rejection of a lot is determined on the basis of the number of failures appearing in the sample. Epstein and Sobel[5] and others have developed basic theory and applied sampling procedures for lot-by-lot life testing for truncated and censored sampling as well as for sequential sampling where the underlying distribution is assumed to follow the exponential.

Sobel and Tischendorf[6] have presented an extensive set of sampling plans for life testing that assures (for various confidence levels) a product having a mean life greater than a specified value. These tables are the basis for the sampling plans appearing in the relatively new general specification[1] on semiconductor devices mentioned above.

The calculation of the operating characteristic (OC) curves for truncated sampling plans assuming the exponential distribution of failure is relatively easy. The proportion of units tested that can be expected to fail by any time T is given by

$$p(T) = 1/\theta_0 \int_0^T \varepsilon^{-x/\theta_0} dx = 1 - \varepsilon^{-T/\theta_0}$$

Therefore, if a sample of n units is tested for T hours, and the number of failing units is determined on an attribute basis, it is easy to compute the probabilities of acceptance as a function of lot failure rate for sampling plans consisting of the sample size (n), the acceptance number (c) and the predetermined test time (T). To illustrate with a specific example, let us assume that a life-test requirement specifies a sample of 47 units to withstand a 1000-hour test with no failures allowed. Table I illustrates the computations. A lot having a failure rate of one percent per 1000 hours would be equivalent (by the reciprocal formula) to having a mean time to failure of 100,000 hours. Since T = 1000 hours, $T/\theta_0 = 0.01$. Referring to a table of the exponential function, p or the proportion of failures expected to fail by 1000 hours is found to be 0.010. With a p value equal to 0.010 and a sample size equal to 47, (pn = 0.47), it is necessary to go into the Poisson Tables (e.g., Table H, *Engineering Statistics and Quality Control*, I. W. Burr, McGraw-Hill) and determine the probability corresponding to c = 0. This value is ascertained as 0.63. Similarly, the probability of acceptance values are computed for lot failure rates up through six percent per 1000 hours.

Fig. 3 presents the OC curves for several life-test sampling plans terminated at 1000 hours as a function of failure rate. The three OC curves go through

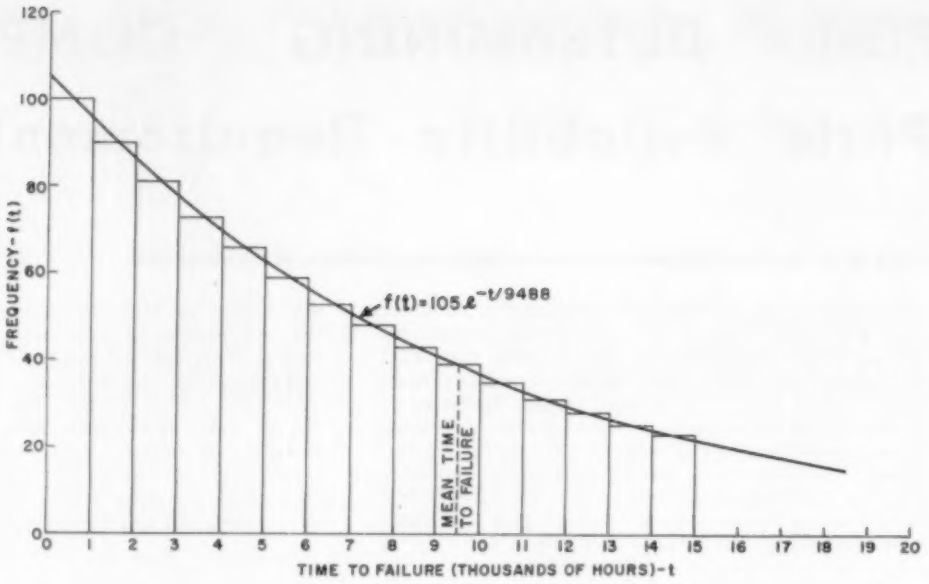

Figure 1—Hypothetical Exponential Frequency Distribution of Times-to-Failure of Electronic Component (Constant Failure Rate = 10 Percent per 1000 Hours — 1000 Components Placed on Test)

the ten percent probability of acceptance point at the five percent per 1000 hours failure rate level. Thus, using the accepted terminology of sampling inspection by attributes, the five percent per 1000 hours failure rate can be designated the "lot tolerance failure rate" with a consumer's risk equal to ten percent. As in ordinary attributes sampling plans, large sample sizes with the allowance of a few defectives give a more discriminating OC curve than a plan with a zero acceptance number.

Table I — Calculation of OC Curve for n = 47 c = 0 T = 1000 hours

(Assuming Exponential Distribution)

Lot F.R. (% per 1000 hours)	θ_0 = 1/FR	T/θ_0	$p = 1 - e^{-T/\theta_0}$	P_a Poisson Tables
0	Infinite	0.00	0.000	1.00
1	100,000	0.01	0.010	0.63
2	50,000	0.02	0.020	0.39
3	33,333	0.03	0.030	0.25
4	25,000	0.04	0.039	0.16
5	20,000	0.05	0.049	0.10
6	16,667	0.06	0.058	0.07

Effects of Test Time, Lot Tolerance Failure Rate and Acceptance Number on Sample Size

It is now desirable to determine what effects differences in length of testing time have on the operating characteristic curves. Fig. 4 depicts the OC curve of two sampling plans having the same sample sizes (n = 47) and acceptance numbers (c = 0), but one plan requires a test time of 500 hours and the other 1000 hours. As is to be expected, the plan requiring the longer test time provides a better protection against the acceptance of substandard lots than the

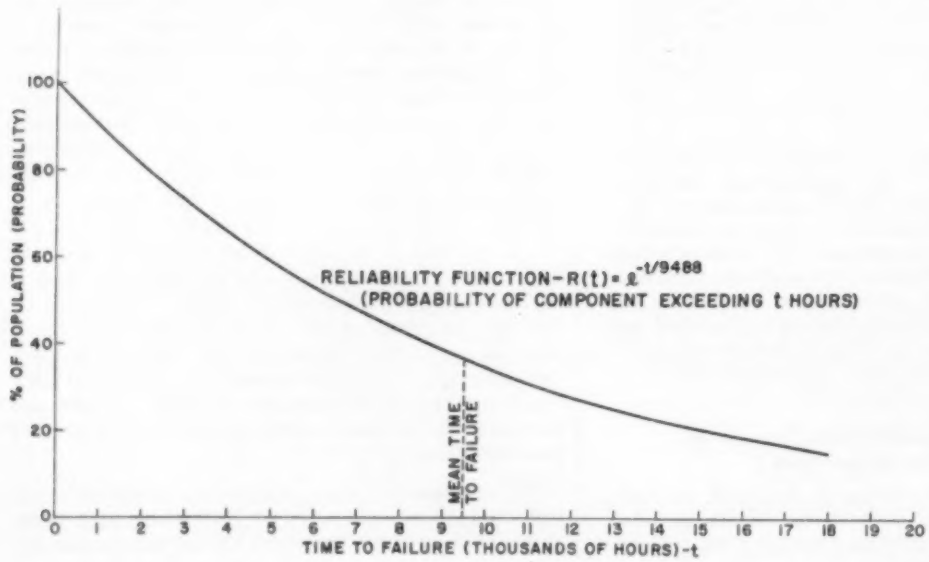
% OF POPULATION (PROBABILITY)
RELIABILITY FUNCTION - R(t) = ℓ^-t/9488
(PROBABILITY OF COMPONENT EXCEEDING t HOURS)
MEAN TIME TO FAILURE
TIME TO FAILURE (THOUSANDS OF HOURS) - t

Figure 2—Hypothetical Reliability Function of Exponential Distribution of Times-to-Failure of Electronic Component (Constant Failure Rate = 10 Percent per 1000 Hours)

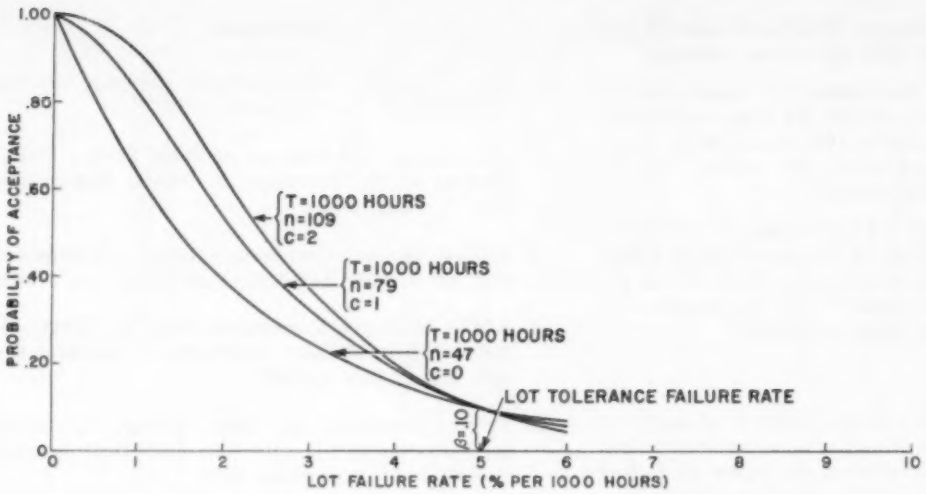

Figure 3—Effect of Acceptance Number on OC Curves for Life Test Sampling Plans (Test Terminated at 1000 Hours)

sampling plan with a shorter test time. In addition, reducing the test time from 1000 to 500 hours increased the lot tolerance failure rate from five percent per 1000 hours to ten percent per 1000 hours.

Figures 5 and 6 provide the relationship between lot tolerance failure rate and the required sample size for various pre-assigned test times ranging from 250 hours to 2500 hours for acceptance numbers of zero and one. By means of these graphs, it is possible to select a particular sampling plan to assure a specified lot tolerance failure rate. For example, suppose it is necessary to meet a lot tolerance failure rate of five percent per 1000 hours, it is possible to extract various sampling plans to meet this requirement (see Table II).

Table II — Sampling Plans to Satisfy LTFR = 5% per 1000 Hours

Test Time	Sample Size	Acceptance No.
250	184	0
500	92	0
1000	47	0
1500	32	0
250	312	1
500	156	1
1000	79	1
1500	54	1

It can be ascertained from Table II that doubling the test time results in approximately halving the required sample size for a fixed acceptance number. More generally, the required sample sizes are approximately inversely proportional to the test times. From a table such as Table II, it is possible to evaluate the various economic factors that should be considered in the selection of a sampling plan. For example, if the test time costs are high compared to the cost of sample units, it may be desirable to subject a large sample to the life test for a relatively short period of time and still satisfy the required lot tolerance failure rate. On the other hand, if the cost of the components is high, it may be necessary to utilize long test times and thus reduce the sample size.

Figures 7 and 8 show the relationship of sample size and test time for various values of lot tolerance failure rate for acceptance numbers zero and one. As specified previously, required sample size is approximately inversely proportional to the pre-assigned test time. Doubling the test time will permit

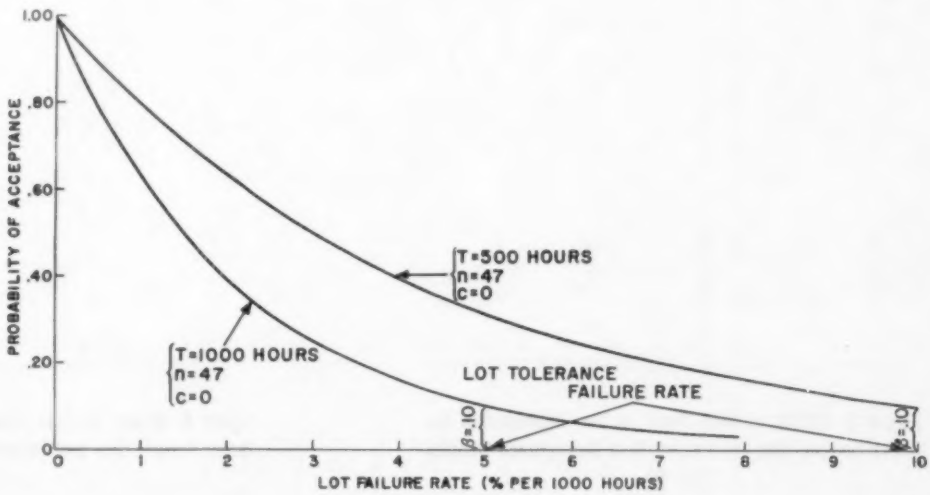

Figure 4—Effect of Test Time on OC Curves for Life Test Sampling Plans

an approximately 50 percent reduction in sample size for a particular LTFR and acceptance number.

Figure 9 shows the relationship of sample size and acceptance number for several lot tolerance failure rates and a test time equal to 1000 hours. As in standard attributes sampling plans, the sample size increases with acceptance number.

The sample sizes that were computed for construction of the various graphs of this paper agree within one unit with the values given in Table IV of the Sobel and Tischendorf paper[6] and the sample sizes specified in Table IV of MIL-S-19500B[1].

Conclusion

This article discussed certain aspects of sampling plans for life tests truncated after a pre-determined time when it is assumed that the times to failure follow the exponential distribution. Sampling procedures of this type will undoubtedly assume increasing importance when specifications for electronic components are revised to include quantitative reliability requirements.

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2. D. J. Davis, "An Analysis of Some Failure Data," *Journal of the American Statistical Association*, Vol. 47, June, 1952
3. ARINC Research Corporation Report: "A Selection of Electron Tube ReliabilityFunctions," Jan. 8, 1958
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5. Epstein, Benjamin and Sobel, Milton, "Life Testing," *Journal of the American Statistical Association*, Vol. 48, September 1953
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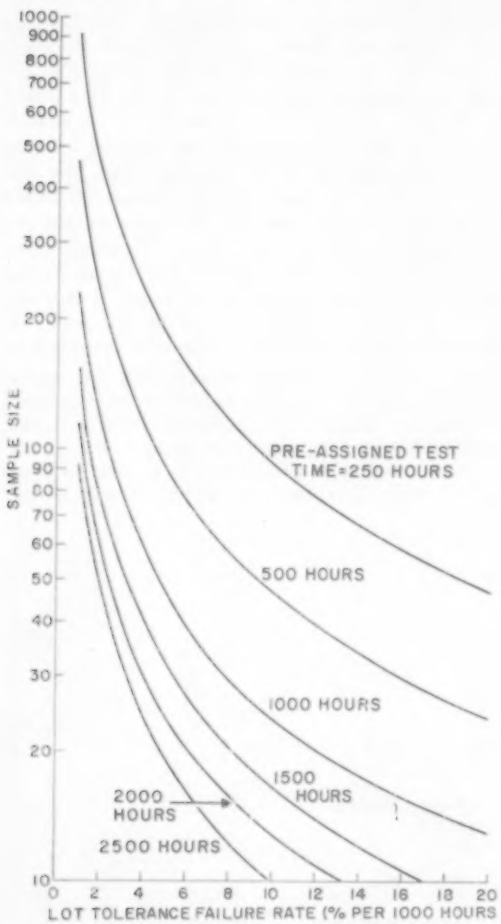

Figure 5—Effect of Test Time on the Relationship between Sample Size and Failure Rate (Acceptance Number = 0)

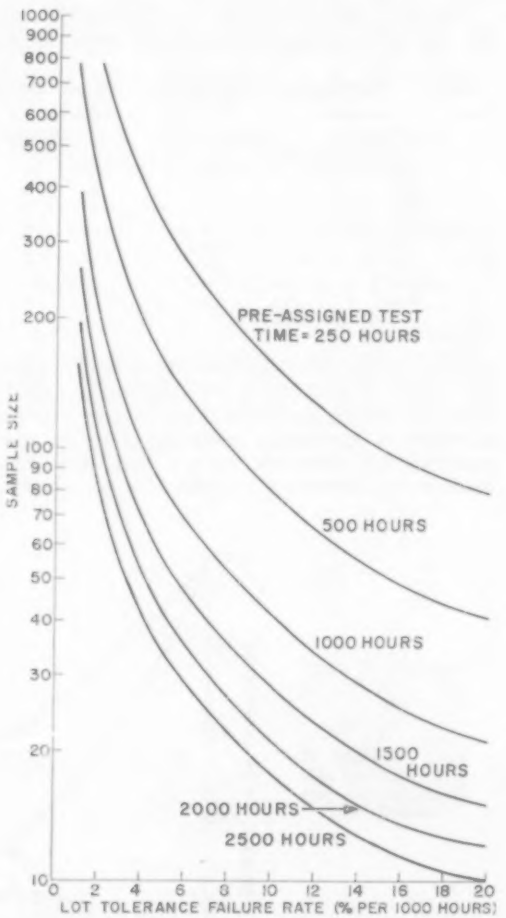

Figure 6—Effect of Test Time on the Relationship between Sample Size and Failure Rate (Acceptance Number = 1)

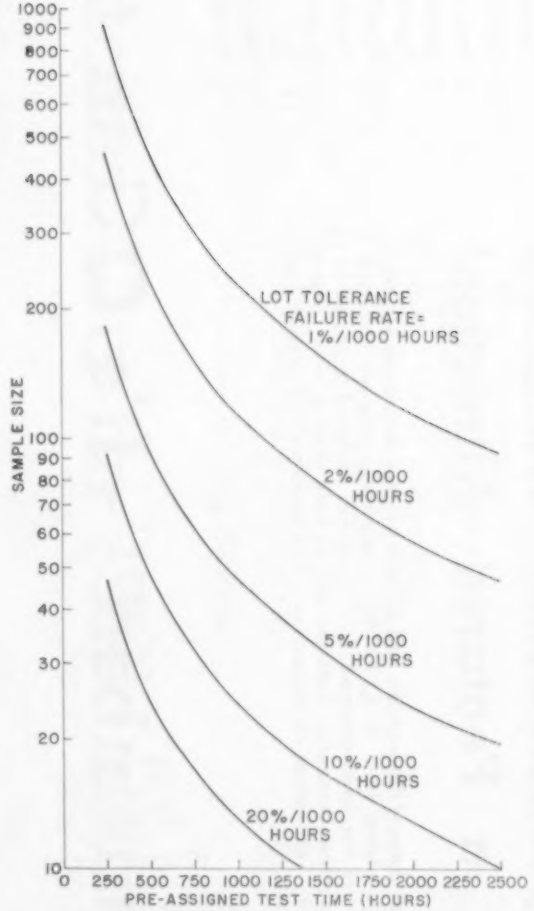

Figure 7—Effect of Failure Rate on the Relationship between Sample Size and Test Time (Acceptance Number = 0)

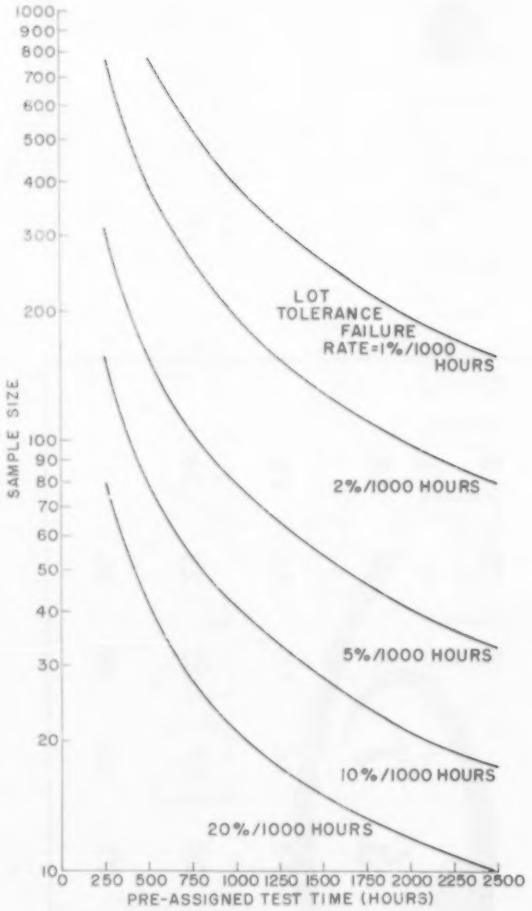

Figure 8—Effect of Failure Rate on the Relationship between Sample Size and Test Time (Acceptance Number = 1)

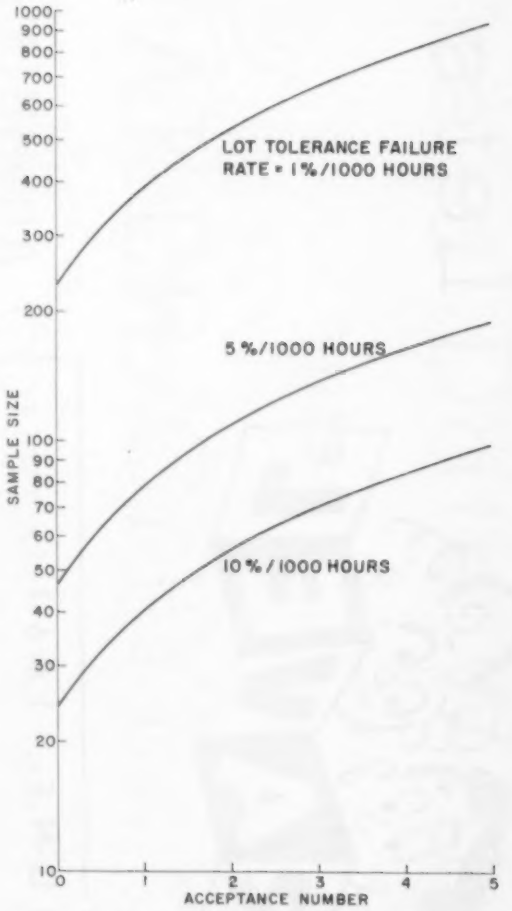

Figure 9—Effect of Failure Rate on the Relationship between Sample Size and Acceptance Number (Test Time = 1000 Hours)

Let's M

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Attend the

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JUNE, 1961						
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"The Inspectioneering Workshop" Will Be a Featured Attraction!

As part of the 15th Annual Convention and Exhibit of your American Society for Quality Control in Philadelphia June 5, 6, 7, 1961, a workshop program (adjacent to the exhibit) for inspectors has been planned. . . . a program designed to appeal to on line inspectors and inspection managers. Sessions will be held dealing with "Management of Inspection" and "Techniques of Inspection". Top speakers will present papers on the following subjects:

1. Inspector Pr
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3. Inspector Re
4. Organizatio Function
5. How To Ha Problems
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5th ANNUAL CONVENTION AND EXHIBIT

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UNE 5, 6, 7, 1961

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10. Dial Gage Maintenance, Repair, Calibration
11. Limitations of Gages Under Unusual Conditions
12. Screw Thread Methodology
13. Inspection's Responsibility and Understanding of Sampling Techniques
14. Advanced Gaging Trends
15. Statistics Made Easy for The Inspector
16. Inspection Working Condition

Quaker City in 1961!

ASQC News

David S. Chambers, Executive Secretary

The Society's Executive Committee met in New York on Sept. 16, 1960. The items that were discussed by the committee, which are of general interest to the membership, are these.

The Food and Allied Industries Steering Committee, under the chairmanship of William Golomski, submitted to the Executive Committee a petition for division status. This petition was approved by the Executive Committee and the formal announcement of the formation of the Food and Allied Industries Division was made in last month's issue of *IQC*.

The petition of the Mansfield, Ohio, members for section status was approved by the Executive Committee. The Society would like to take this opportunity to welcome Mansfield to its family of sections as the 115th section. The Society would also like to welcome the Oklahoma City, Southern Illinois and Santa Maria-Vandenberg sections whose petitions were approved by the Executive Committee since the last appearance of the ASQC news department in January 1960.

112—Oklahoma City, Okla.
(Dist. 13)

Chairman:
Lloyd E. Ervin
United States Air Force
Oklahoma City, Okla.

Vice Chairman:
G. E. Gastineau
Tinker AFB, Okla.

Secretary:
Arthur G. Schricker
4321 N.W. 47th St.
Oklahoma City, Okla.

Treasurer:
Melvin E. Thornton
Tinker AFB, Okla.

113—Southern Illinois
(Dist. 12)

Chairman:
Cliff Statler
Universal Match Corp.
Marion, Ill.

Vice Chairman:
Virgil Wimmer
Olin Mathieson Chem. Corp.
Marion, Ill.

Secretary-Treasurer:
Randell Blockley
Ordill Div.
Sangamo Electric Co.
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114—Santa Maria-Vandenberg
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528 Pine Ave.
Salvang, Calif.

Vice Chairman:
Francis R. Krause
Vandenberg AFB, Calif.

Secretary:
James O. Shippen
Lockheed Missiles System
Santa Maria, Calif.

Treasurer:
George McFadden
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115—Mansfield, Ohio
(Dist. 8)

Chairman:
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Vice Chairman:
Ralph Nottingham
Northern Electric Co.
Galion, Ohio

Secretary:
Stanley Freeman
Westinghouse Electric Corp.
Mansfield, Ohio

Treasurer:
Egon Loeckel
Westinghouse Electric Corp.
Mansfield, Ohio

The Joplin, Missouri, section asked the Executive Committee for permission to change its name to the Joplin-Springfield section, since its membership was split between the two cities. The section's request was approved.

The site of the 20th Annual Convention and Exhibit of the Society was selected as New York City. The Statler Hilton will be the headquarters hotel and the Convention will be held on Wednesday, Thursday and Friday, June 1-3, 1966.

The Society's insurance administrator offered to the Executive Committee a proposal for a group life insurance program to be offered to the Society membership along with the major medical insurance which is currently being offered. The group life program was referred to a committee for further study. A. B. Mundel was appointed chairman of this committee. In addition to studying the structure and rates of the program he would also like to determine the extent of the demand among the Society membership. Accordingly, members who think they might be interested in a low-cost life insurance program of this type are requested to contact Mr. Mundel at Sonotone Corp., Elmsford, N. Y.

The next item of interest to the membership was a proposal by the Society's Examining Committee for an amendment to the Constitution which would permit the dues of all members to be automatically increased to those of Senior members after a period of nine years. This proposed amendment parallels a similar one that was approved by the membership two years ago whereby associate members' dues are automatically increased to those of member grade dues at the end of a six year period.

This procedure of an automatic dues increase to the next higher membership grade after a suitable length of time is practiced by a number of societies. It is based on the reasoning that the members of professional societies should want to improve themselves professionally by advancing through the various grades of membership as soon as they become eligible. Failure to do so is frequently the result of an oversight. Therefore, an integral part of the proposal is that each member will be notified one year ahead that he will be eligible to advance to the next grade. Whether or not the member then decides to apply for advancement, he will still be required to pay the additional dues.

The Executive Committee approved the proposed amendment for submittal to the Society's Board of Directors. If Board approval is obtained, the amendment will then be submitted to the membership on the Annual Ballot next spring.

The final item of interest to the members that was discussed by the Executive Committee was the report of the Real Estate Committee. For several years now the Society has rented its offices. In 1948 the Society opened a headquarters office in New York City. Then in 1952 a second office was opened in Milwaukee. Finally in 1956 both offices were consolidated in Milwaukee.

A few years ago the Society management appointed a Real Estate Committee to investigate the pros and cons of the Society buying or building its own headquarters building. Two considerations have been paramount in the minds of the committee during the course of the studies. One of the considerations was the advantage of providing a means of diversifying the investment program. Up to the present time all surplus funds have been invested in the Securities account. There seems to be some advantage to considering the possibility of investing a portion of the future available funds in real property. The second consideration was the economic advantage to the Society of owning its own headquarters building versus renting. This phase was covered in a detailed report presented to the Executive Committee at its September meeting. Subsequent reports will be made to the Board of Directors and Society membership as the specific planning becomes more concrete.

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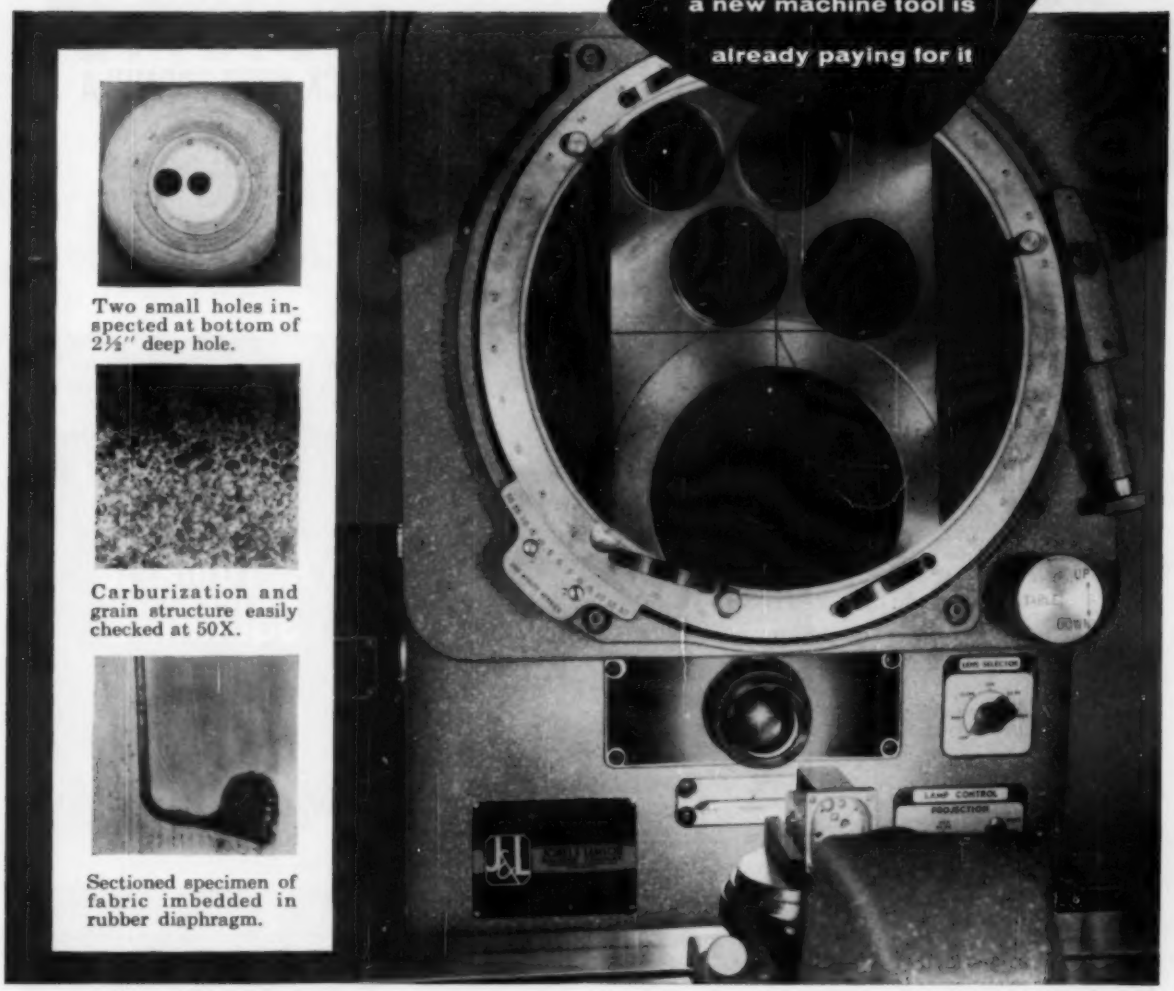

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section briefs

Committee members for the Los Angeles Section Second Annual Reliability Symposium are Joseph Loesch, Dr. E. P. Coleman, Lee Gray, Jack Lancaster, Irving Quart, R. E. Biedenbender, Martin Saltz, Steve Kozich and Grant Ireson. Not pictured are R. Dambrow, H. Matesoff and A. Rothstein.

AKRON-CANTON . . . This year's activities got off to a bang-up start. Richard Holmes of Carrier Corporation spoke on "QC in Incoming Inspection," to the largest attendance at a first fall meeting in the history of our section. It was also very encouraging to have such a large group of guests on hand.

The educational committee of Bob Archer, Larry Miller, and Harold Baker report that the training program which started in September had a total enrollment of 82 students. Enrolled were 57 for IQC #1, 31 at Canton and 26 at Orville. At Canton, an additional 25 enrolled for IQC #2. Graduation ceremonies and dinner will be held Dec. 7 at the Sachsenheim Club in Canton.

H. P. Pierce

ALLENTOWN-BETHLEHEM . . . Our initial meeting for the 1960-61 season got off to a flying start Sept. 14 at the Hotel Traylor, Allentown, Pa. It was a dinner meeting and the feature of the evening was a talk by Richard S. Bingham, Carborundum Co., Niagara Falls, N.Y., on "Modern Uses of the Range." Mr. Bingham acquainted us with several unusual and very effective ways in which to make use of the range to maintain control of processes at the shop foreman level without going through a maize of statistical formulae and mathematical calculations. The evening was particularly enjoyable to us because the speaker was a founding member of our section and has moved on to greater things. It was good to have him back with us after an absence of several years.

This year's educational program was started Sept. 26, at Muhlenberg College with 14 persons enrolled in our basic course taught by section members.

David F. Roberts

BALTIMORE . . . The "kick-off" of the new section year in September was a conducted tour of the facilities of the 104th Fighter Squadron, Maryland Air National Guard. Major J. I. Considine, Base Supply Officer, prepared an outstanding agenda to explain the elaborate QC inspection and maintenance control program used for the aircraft at this facility. This was the highlight of the tour with emphasis on assuring that aircraft are kept in the best flying condition.

The program for this new year consists of eight meetings, with one meeting set aside for papers contributed by members of this section. It was unanimously agreed that this type of participation would aid in the growth of the section.

A. M. Reek

BATTLE CREEK-KALAMAZOO . . . Our fall training course that began Sept 12, in the Charlotte, Mich., high school, got off to a great start. The enrollment went beyond our maximum of 30 students, so we began a second course on the following night. The second course was held in Hastings, Mich. The course provided a general understanding of the various techniques used in process analysis and control, with emphasis on which method to use, how to gather data and how to interpret and make use of results. William A. Schideler, QC director of Eaton Manufacturing Co., instructed both sessions.

Charles C. Beazley, our education chairman, gave a talk entitled "Factorial Quality Control," at the American Institute of Chemical Engineers National Convention in Tulsa, Okla., Sept. 25.

Peter F. Koetz

BOSTON . . . This season each dinner meeting is preceeded by a pre-meeting session, sponsored by an ASQC division. For the December session, William Grady, Carter Ink Co., will present "Statistical Techniques for a Chemical Process Laboratory." In January, Ken Gleason, Gillette Safety Razor Co., will discuss "Control of Incoming Material."

These pre-meeting sessions start at 5 p.m.

For the first meeting of the season, 40 attended the pre-meeting sessions and 100 heard Dr. A. W. Wortham, Texas Instruments, Fort Worth, Texas, discuss "Total Quality Control — Evolution or Revolution."

Our junior past chairman, Dorothea Looney, Polaroid Corp., was presented an article of jewelry as a token of appreciation by the new chairman, W. A. Donovan.

The Merrimac Valley sub-section sponsored a most

Electronics Division Luncheon

On Jan. 9, during the Seventh National Symposium on Reliability and Quality Control, the ASQC Electronics Division will hold a luncheon in the Tecumseh Room of the Bellevue-Stratford Hotel, Philadelphia, Pa.

Reservations are being accepted by Alexander Sternberg, Division Councillor, District 5. Contact Mr. Sternberg, Sonotone Corp., P. O. Box 200, Elmsford, N.Y.

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successful One Day Symposium Sept. 18. Eight papers were presented.

H. L. Keefe

BUFFALO . . . An educational conference was held Sept. 17 at the University of Buffalo. Sigmond Zobel, Carborundum Co., Niagara Falls, N.Y., was general chairman of the conference committee.

Other members of the committee included: vice chairman — A. Stein, Cornell Aeronautical Laboratories, Inc.; treasurer — W. F. Kubisty, Jr., U.S. Navy; secretary — R. Stohr, the Carborundum Co., and university liaison — Mrs. Ethel Schmidt, University of Buffalo.

The program was designed to provide management and supervision with the fundamental facts of statistical quality control, its objectives and its methods. At the same time, for those conferees who were already familiar with basic QC, new applications or approaches were discussed. An added feature were the consultation hours, during which any registrant might seek advice on any related problem.

The program was divided into three series — What every manager (and his staff) should know about statistical QC, new and broadened horizons, and consultation with an expert on individual problems.

Speakers, moderators, panelists and consultants included: R. Banas, Carborundum Co.; A. Haven, Trico Products Corp.; A. Stein, Cornell Aeronautical Laboratories, Inc.; N. Hodge, Great Lakes Carbon Corp.; A. Ritter, Hooker Chemical Corp.; J. Quirk, Carborundum Co.; V. Grom, Scott Aviation Corp.; H. Houghland, Chevrolet Motors Division of GMC.; W. Toporczyk, American Machine & Foundry Co.; W. Kubisty, U.S. Navy; V. Shelburne and S. Zobel, Carborundum Co.

Irving Gordon

CHATTANOOGA . . . The fall season started off with the September meeting under our new chairman, Vernon Thompson. A talk by Hank Madden, American Lava, on "$\bar{X}$, R Charts — Case History," drew section members from nearly 100 miles away. A door prize also aided in bringing out some errant local members.

John L. Rose, Jr.

CHICAGO . . . The Chicago Association of Commerce and Industry and the Chicago section of ASQC held the 15th Annual Two Day Training Course in Quality Sept. 29-30, at the Graduate School of Business, University of Chicago.

Dr. John A. Henry, University of Illinois, together with Dr. Gayle E. McElrath, University of Minnesota, conducted the condensed, intensive training course in QC fundamentals. Seventy-nine attended the sessions — one short of capacity.

The Chicago section's course in Precision Metrology held its first of 15 sessions Sept. 15 at the University of Illinois, Navy Pier.

The chairmen — G. B. Schlett, Lufkin Tool Co., and T. W. Mitchell, DoALL Co., have an excellent format. The intent of this course is to keep QC personnel abreast with the most modern inspection equipment and its applications to QC operations.

The Chicago section congratulates these course instructors!

John L. Dittrich

CLEVELAND . . . Hurricane Donna forced postponement of the first meeting to Sept. 16. P. B. Crosby demonstrated by pictures and diagrams the complexity of Martin Company's QC program. His talk on "Development of a Quality Control Program for a Multi-Plant Operation" certainly showed the care and precaution that goes into the government's missile program.

Howard O. Schmidt

COLUMBUS . . . The section held its first dinner meeting of the year at the Columbus General Depot Officers' Open Mess.

Guests were welcomed by Brig. Gen. Harold H. Shaller. An interesting meeting followed an enjoyable steak dinner.

The discussion topic was "QC Applications at the Columbus General Depot." The speaker was John S. Alden, assistant for technical staff activities, QM Quality Control Agency.

The section will hold a joint meeting with the Columbus Chapter of the American Institute of Industrial Engineers Dec. 15, at 6 p.m. The topic — Machine Capabilities and How Its Analysis Provides an Objective Communication Channel Between the Industrial Engineers and QC Engineers.

On Jan. 4, the Columbus section will hold a joint dinner meeting with the Columbus Chapter of the American Society for Metals to discuss "Metallurgical Quality Control."

George E. Arris

CORNING . . . The season's first dinner meeting was held at the Hickory House in Horseheads, N.Y. Fifty members and guests were present for the kickoff on September 13.

Sid Fielden, staff statistician, IBM Data Processing Division, White Plains, N.Y., discussed the "Need for Effective Transmission of the Purchaser's Quality Needs to a Vendor, and the Necessity of Having Some Standard Acceptable Means of Doing So. The Instrument developed by IBM for this purpose is the Quality Specification or "Q-Spec." Covered in the presentation were the philosophy, construction, and interpretation of the "Q-Spec."

The annual plant tour will be held Jan. 10.

Richard J. Gibson

CHARLESTON . . . The fall season was introduced Sept. 15 by a dinner and social hour which were held before the main event of the evening. At this time, one of our well-known section members, Jack Massau, gave an interesting paper on "Programming of Laboratory Data," based upon his experience at the Belle Works of duPont.

T. F. Costello

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DALLAS-FORT WORTH . . . The September meeting featured Dr. Leroy Folks, quality assurance manager, Texas Instruments, Inc., Dallas, Tex. Dr. Folks brought an interesting and provocative talk on "Experimental Error — What Is It?"

The management development committee is planning a Management Night for the meeting Dec. 8. While plans are incomplete at this time, it is planned that this will be a dinner meeting to be held at the Club Southwest. A panel of prominent local leaders in QC will discuss QC methods and techniques used in their companies to reduce costs and improve quality. A special effort will be made to encourage attendance of executives of companies not presently represented in section activities.

R. R. Massegee

DELAWARE . . . The Delaware section is trying a new pitch on a new level to increase its membership. We intend to contact plant managers of all major industries in Delaware and nearby areas of Pennsylvania, New Jersey and Maryland. We are inviting them to send their QC or inspection people to a dinner meeting to learn the basic notions and benefits of statistical quality control.

Our speaker for this occasion is Dr. Ellis R. Ott, chairman of the Statistics Department at Rutgers • The State University, New Brunswick, N.J.

The section started the new program year with a very successful Ladies Night program. Hillman Harris' talk on "Probability and Games of Chance" was interestingly presented. Ken Horowitz, our program chairman, commented at the end of Hillman's talk that the speaker was a "kill joy" and that he was sure that everyone would leave sad but wiser.

Dr. Max Astrachan, Rand Corp., will speak on "Operations Research," a system which has recently attracted much publicity in relation to national defense projects. It first came into prominence during World War II when a group of scientists tried to seek a solution to the deployment of a limited number of ships against Nazi U-Boats in the Atlantic. It is also applicable to the solution of a number of complex business problems involving marketing and competitive aspects of a corporation. The Delaware section will be looking forward to his talk on Thursday, Dec. 1.

Marvin Thompson

GREATER DETROIT . . . The section met Oct. 3 in the restaurant and lecture room of the Burroughs Corp., for dinner and a movie, *Toshiba*, and also a talk by Howard Sprengel, QC director for the Tank and Automotive Command of the Detroit Ordnance District.

Mr. Sprengel gave a lively and pertinent talk on the quantity of Japanese imports, together with a description of their greatly improved quality. Quality of goods for export is regulated by a government bureau. The movie described the manufacture of electrical equipment.

Raymond Schoof, Burroughs International Division, presided at the meeting in the absence of Charles Tomlinson, program chairman. Mr. Tomlinson's father had died unexpectedly.

The December meeting will be held in Ann Arbor, Mich., at the Hoover Ball and Bearing Co. Dale Cue, QC director, will be the speaker.

The last two board meetings have dealt with details of the year's program and the planning of publicity.

Frances D. Huntington

GREATER MUSKEGON . . . Our first meeting was held at Bill Stern's on Sept. 8. A family style chicken and ham dinner was enjoyed by 35 members and guests.

Charles Beazley, General Foods Corp., Battle Creek, Mich., discussed "Factorial Quality Control." His talk was most interesting. During the meeting a number of pictures were taken for our scrap book.

Our meeting Dec. 9 will feature John G. Rutherford of Lear Inc. His discussion of QC at Lear will precede a tour of Lear Inc., at our January meeting.

Thirty have been enrolled in our basic quality control course.

William A. Hume

HAMILTON-MIDDLETOWN . . . The Dec. 7 meeting will be held at the Student Center, Miami University, Oxford, Ohio, with the DoALL presentation of "The Cutting Edge."

With the co-sponsorship of Miami University and the Cincinnati section, the Hamilton-Middletown section is having this excellent presentation in the Hamilton, Dayton and Middletown areas. Everyone engaged in manufacturing industries will be interested in this presentation. It consists of physical displays of examples of cutting edges dating fifty thousand years ago, and includes a lecture with slides. This presentation is all inclusive, and those who have seen neither this presentation nor DoALL's story of measurement will not want to miss this meeting.

Lon Ely

HARRISBURG . . . The education committee has gotten off to a good start with three courses well attended. It appears the section will be securing several new members as a direct result of these courses. The program committee has completed the mailing of the wallet size program cards to all members as of Sept. 25.

The Dec. 7 "Buzz Session" dinner and meeting is scheduled for the Veterans of Foreign Wars, 617 W. Market St., York, Pa. This has always been a well attended meeting in the past and this year the section plans to invite mathematics students and their teachers to be guests. All colleges in the area will be contacted. The evening's speaker will be Michael A. O'Hanlon, Jr., assistant manager, AMP, Inc., Carlisle, Pa.

On Jan. 4, Fred Gropper, E. I. duPont, Wilmington,

Dela., will discuss "Operations Research," during a joint meeting with ASC at the Arcadia Cafe, 27 W. Orange St., Lancaster, Pa.

A. C. Englehart

HARTFORD . . . Paul Shuttleworth of Standard Pressed Steel Corporation will discuss the "Aspects of Fastener Reliability," Dec. 13. A movie, the "Search for Reliability," will also be shown.

The five course program developed by the section's education committee has enrolled 100 persons. Course titles and instructors are: basic statistical QC — E. Ellis, QC engineer; Pratt & Whitney Aircraft; intermediate statistical QC — F. Hauman, quality assurance supervisor, Underwood Corp.; engineering statistics — L. Sespaniak, operation research supervisor, Pratt & Whitney Aircraft; basic inspection and gaging — K. Martin, QC engineer, Holo-Krome Screw Corp., and inspection organization and methods — C. Chilone, QC manager, Anemostat Corp., and A. Manzi, quality manager, Sunner Chuck.

L. Sespaniak

HUNTSVILLE . . . On Sept. 22, the section held the first meeting of the season at the Elks Club. Samuel L. Patton, section chairman, presented "Vendor Quality Certification." The paper was written by our scheduled speaker, Judson G. Jarvis, Wolverine Tube, Division Office, Detroit, Mich., who was not able to attend the meeting. The program also included a film, the "Price of a Goof," produced by the Army Ordnance Missile Command.

The Annual Quality Control Conference was held at the University of Alabama. The conference is sponsored by the Huntsville and Pensacola-Mobile ASQC sections and the University of Alabama.

During December the Huntsville section will have a party for ASQC members and their guests to celebrate the Holiday season.

Barry E. Davis

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STATE UNIVERSITY OF IOWA . . . The new year was opened Sept. 23 with a very interesting talk by Joseph Movshin, management consultant, St. Louis, Mo. Mr. Movshin stressed the importance of simple procedures and presentations to operating personnel during his talk on "Training and Motivation for Successful Quality Control."

E. B. Godsey

KANKAKEE-JOLIET . . . At the Fall kick-off meeting Sept. 13, the section heard Warren E. Jones, senior partner, Management Controls, present an interesting and informative illustrated talk on "Scientific Tolerances and Waste Control."

On hand to hear this presentation were 37 members and guests from the Kankakee-Joliet, and the Chicago Heights area.

Officers for the 1960-61 season are: chairman — John Jeffrey, Caterpillar Tractor Co.; vice chairman — William Rietz, Simonize Co.; secretary — Charles Grosche, General Foods Corp.; and treasurer — Robert McKeague, U.S. Army Ordnance Ammunition Command.

C. A. Grosche

KANSAS CITY . . . The section held its first meeting of the season Oct. 3, at the Schlitz Brown Bottle Guest Hall.

After dinner there was a short business meeting at which plans for coming meetings were reviewed. Fourteen new members were introduced along with a large number of guests, including Bonnie Small, who is visiting Western Electric in Kansas City.

Don Waldman, QC superintendent, Schlitz, spoke on controls used in packaging at Schlitz. He had an interesting display of instruments used in checking temperature, etc., during packaging. A film was also shown about the growth and development of the Schlitz Co.

H. Afton Taylor

LEXINGTON . . . Three trends which American businessmen must take into full account to design, process and sell products competitively in today's marketplace were outlined during the September meeting.

Stephen T. White, General Electric Co., listed these trends as: 1. Customers, both industrial and consumer, have been increasing their quality requirements in recent years: 2. As a result, in-plant quality practices and techniques are now being outmoded, and 3. Quality costs have become very high, and are now a very important element of product cost.

He said that taken together these trends spell out the twin quality objectives that today's competitive conditions present to American business management: 1. The quality of many products must be considerably improved, and at the same time, 2. Costs of maintaining quality must be substantially reduced.

The meeting was held at the Lexington Signal Depot.

J. C. Graff

LIMA . . . On Sept. 13, the Lima section met at Cooper Tire & Rubber Co., Findlay, Ohio. H. W. Poole, QC director, Superior Tube Co., Norristown, Pa., spoke on "Organization & Operation of QC Systems."

Following the talk, a plant tour was conducted through the fastest growing rubber company in the United States. The meeting closed after refreshments and recognition of new and transferred members.

The basic layout course and basic statistics course were offered Sept. 26 by the Lima section and enrollment totaled 43 for layout and 14 for statistics. The eight week courses were held at Lima Senior High School.

The story of the cutting edge by DoALL will be presented at the Dec. 6 technical dinner, 6:30 p.m. at the Clemans Building.

On Jan. 10, 7:30 p.m., D. C. Fultz, Ford Motor Co., will present a play on sampling inspection. The meeting will be held at the Superior Tube Co., Wapakoneta, Ohio.

E. K. Anderson

LOS ANGELES . . . On Sept. 27, 420 persons attended the North American Panel section meeting. Panel members included J. C. Beerer, president, Missile Division;

J. W. Young, vice president, Quality and Logistics; J. B. Matson, chief Structures and Systems section, Missile Division. Mr. Mattson gave a very interesting explanation of NAA's Quality Verification Program.

Gordon Drake and Howard Todt pointed out, at the executive council meeting Sept. 29, that for a meeting of this size there is a need for a sargeant-at-arms and ceiling signs to help direct people to the clinics, dinner ticket desk, displays and guest room.

The meeting Dec. 14, will be handled by the Marquardt Corp. The spot light speaker Roy Marquardt will describe the "Marquardt Corporation's Management View of Quality Assurance."

Mr. Walters, the guest speaker, will discuss "Quality Assurance in the Power Systems Group Division."

Steve Kozich

MEMPHIS . . . On Sept. 27 at the Memphis State University Library, our kick-off meeting for the new season featured Eric Dudley Robinson. Mr. Robinson made a very informative talk on "Some New Quick Ready Statistics for the Laboratory Chemist." Mr. Robinson is QC manager for Plough, Inc., Memphis, Tenn.

William L. Dickerson, Jr.

METROPOLITAN . . . On Sept. 10, the 12th Annual Rutgers All Day Conference on QC was well accepted with a total attendance of 562. Six simultaneous panels were presented in both the morning and afternoon sessions. The traditional roast beef was served in the University Commons and had Dr. Marion A. Johnson as toastmaster. The luncheon speaker, Vice Admiral G. F. Hussey, Jr., USN, (Ret.) and his address "Standards — A Tool for Quality Control in Industry," was thoroughly enjoyed by all.

Another highlight of the conference was an exciting program of ladies activities which included distribution of door prizes and interesting gifts from industries in the area for the 58 wives or daughters in attendance.

Chairman Edwin Schecter and his entire conference committee are to be congratulated for putting together such a fine conference, which included basic concepts, advanced techniques, as well as applications in many fields.

On Dec. 3, the Princeton Conference will be jointly sponsored by the Metropolitan ASQC section and the Physical and Engineering Sciences Section of the American Statistical Association and under the chairmanship of Thomas Shahnazarian. The luncheon speaker will be Joseph A. Gwyer, Library of Congress, who will speak on "QC in the USSR." Arrangements will be handled by Dr. S. Wilks of Princeton, and publicity by Andrew A. Palazzolo of Kraft Foods, Inc., Hillside, N.J.

Stephen G. Orban

MEXICO CITY . . . On the 7th of September was celebrated the 9th Anniversary of the section "Ciudad de Mexico." Several personalities of the industrial areas as well as members of the Chamber of Commerce and personnel of the Government Standards Office were invited.

Domingo M. Lopez

MID HUDSON . . . On Sept. 6, the section held its first meeting of the fall season at the Hotel DiPrima in Highland, N.Y. Dorian Shainin discussed "Are QC Textbook Techniques Obsolete?" He cited several examples where the standard approach would be useless for solving many of today's problems in QC.

Vassar College was the cite of the Mid Hudson section's One Day Seminar on Sept. 17. The Seminar was extremely successful and well managed under the chairmanship of Carl Wetzel of IBM, Poughkeepsie, N.Y. There were 250 registrants representing 38 companies and six states.

Sixteen speakers provided topics of a diversified nature for the morning and afternoon sessions.

On Dec. 6, the Mid-Hudson section will hold a joint meeting with five other technical societies in this area. Jerome Barnum will be the guest speaker. He will discuss "How to Sell Your Ideas." The joint meetings in the past have been a big success and we anticipate that this year's meeting will be the largest gathering of technical societies ever held in this area.

E. L. Leadbitter

MILWAUKEE . . . "Total quality control is something more than techniques, something more than bits and pieces," it was learned when Dr. A. V. (Val) Feigenbaum, ASQC vice president, vigorously boosted the Milwaukee section's program season off the launching pad. It was Management Night on Sept. 27, and about 100 persons gathered at the Milwaukee Inn to hear and watch Val as he described the technologies of total quality control, its place in the strategy of top management, and the new demands it makes on the quality control engineer.

Val's appearance was dramatic from another point of view. In November, 1959, he was unable to arrive in time for his scheduled talk before the Milwaukee section, as a vicious snowstorm had prevented his plane from landing. He arrived the next day, 23 hours late.

In September, 1960, his plane arrived one hour earlier than scheduled due to airline confusion over daylight saving time. "This strengthens my faith," he wittingly remarked, "in the law of averages."

The section has selected Dec. 12 as their annual "Ladies Night." The group will be treated to cocktails, dinner and entertainment.

Darrell G. Schroeder

MINNESOTA . . . Green Giant at La Seur supplied its usual wonderful meal of fried chicken and corn on the cob for about 66 members and guests Sept. 10. It was good to see old friends again after the summer vacation and also find several prospective members and their wives enjoying the social evening.

The fundamentals course started during October with 25 enrolled.

Violet M. Rice

St. Louis Seminar January 11-12

Considerations, techniques, examples and case studies of quality control programs will be thoroughly covered in a seminar Jan. 11-12, at the Chase Park Plaza Hotel, St. Louis, Mo.

"Quality Control for Improved Production," is the theme of this highly important program that is co-sponsored by the ASQC and the ASTME.

Dr. A. V. Feigenbaum, General Electric Co., an ASQC vice president, will lay the foundation for the Seminar with his paper on "Quality Control—the Master System for Improved Production."

Other noted speakers will thoroughly discuss such subjects as "Air Gaging Systems," "Nuclear Gaging (Radioisotopes)" and "The Role of Electronics in the Quality Control System."

A case study of "Quality Process Control in a Complex Assembly" is only one of many examples that will be presented at this program.

A QC Open Forum Panel Discussion will give participants an opportunity to bring their problems to the attention of this distinguished panel.

MONTREAL . . . A successful "kick-off" meeting was held at Dow Brewery Ltd. in very suitable surroundings Sept. 21. About 60 members and guests enjoyed the hospitality of the firm and renewed friendships. Dr. H. R. Wallace of Dow Brewery spoke on the quality control system and its application in his plant.

On Dec. 7, the section will meet in the Canadian Industries Ltd. Bldg. and will be addressed by David Arthurs of Sir George Williams University. He will speak on "Possible Solutions for some Problems in Communication." He will present some ways in which the principles of General Sematics can be used to improve communication.

Mr. Arthurs has received a Bachelor of Paedology Degree from the University of Toronto, and a master of arts in science and mathematics from Acadia University. He is a lecturer in General Sematics at Sir George Williams University and head of the Science Department of Baron Bying High School.

T. F. Waterston

NEW HAMPSHIRE . . . On Sept. 21, Albert E. Aubin, QC manager, Underwood Corp., Hartford, Conn., spoke on "Assembly QC of Complex Equipment."

J. E. Tarrant, Jr.

NORTHEAST TENNESSEE . . . The first post-vacation meeting Sept. 13 was a marked success. The meeting was a "Ladies Night" at Tennessee Eastman Cabin in Kingsport. Dancing, before-dinner refreshment, and recreational facilities were provided early in the evening. The dinner at 7 p.m. featured a 16 ounce steak.

M. L. Snow, QC manager, Atomic Energy Division, Westinghouse Corp., Pittsburgh, Pa., was the guest speaker. He spoke on "Fundamentals of QC with Case Histories." Mr. Snow related experiences in QC installation and implementation in various business organizations.

Seven new members were initiated into the section at the September meeting.

The meeting was attended by 27 members and 23 ladies.

M. Gomez

OMAHA-LINCOLN . . . On Sept. 9, Gayle McElrath, University of Minnesota, St. Paul, Minn., described the "Big Picture" to a guest night group of 43 in Omaha, Nebr. His topic dealt with the role of SQC and why and how it fits into an organization. The talk was very well presented and received.

T. C. Anker

ORLANDO-CAPE CANAVERAL . . . The 1960-61 season was kicked-off with a fine turnout for our first meeting. W. A. Warstedt, quality manager, Schlitz Brewing Co., Tampa, Fla., gave an excellent talk on "Quality Control in the Brewing Industry." Samples of his fine quality product were available for the members and their guests.

A well diversified program has been scheduled and the enthusiasm of the new officers and committee chairmen indicate that we should look forward to an interesting and successful year.

John T. Haga

PARKERSBURG . . . The opening meeting was held at the recreation hall of the Union Insulating Plant, South Parkersburg, W. Va., on Sept. 21. The meeting was a get-together for old and new quality controllers. The evening was spent in discussion and indoor games. Refreshments were served by our genial hosts at the conclusion of the meeting and everyone's reaction was "thanks!" to the company for a wonderful time.

C. B. Moore, duPont Engineering Department, will describe "Atomic Radiation Uses in Quality Control," Dec. 14 at 7:30 p.m. at the Chancellor Hotel, Parkersburg, West Virginia.

Robert R. Stewart

PENSACOLA-MOBILE . . . As guest speaker at the first meeting of the season, Frank Caplan, Westinghouse Corp., spoke on "Incoming Inspection and Vendor Relations." Mr. Caplan expressed the idea that many problems which occurred between a procuring activity and a vendor are a result of a lack of communication. Collective effort between engineers and management is necessary so that a clear and concise channel of communication can be established between the buyer and the seller.

We were very happy to have Mr. Caplan speak to our organization. We are in a good position to learn much about QC from a man with his qualifications. Mr. Caplan's industrial experience includes engineering and supervisory positions in QC with Camillus Cutlery Company and General Electric Co. At present he is manager of the QC and Material Manufacturing department at Westinghouse Corp.

Walter D. Nencka

The president of the Philadelphia Textile Institute, Dr. Bertrand W. Hayward, welcomes the group at the Philadelphia Section Fifth Annual Symposium, which was held in September. The main speaker of the Symposium, Dr. Julius Grodinski, University of Pennsylvania, is in the foreground.

Reliability and QC Symposium January 9-11 In Philadelphia

The Seventh National Symposium on Reliability and Quality Control will be held Jan. 9-11, 1961, at the Bellevue-Stratford Hotel, Philadelphia, Pa.

Proceedings of the six previous Symposia are now in stock for prompt shipment. Within the past year, stocks of four of these — First, Second, Third and Fifth — had become depleted. Paperbound copies of these four have now been reprinted and are in stock for the filling of orders.

Orders for desired volumes, at $5 net, each volume, postpaid, should be sent to the Editorial Department, Institute of Radio Engineers, 1 East 79th St., New York 21, N.Y.

The Symposia are sponsored by ASQC, IRE, AIEE and EIA.

For additional information on the Seventh National Symposium on Reliability and Quality Control Jan. 9-11, 1961, contact R. L. Schwerin, vice chairman, publicity committee, ACF Electronics Division, ACF Industries, Inc., 11 Park Place, Paramus, New Jersey.

PHILADELPHIA . . . Chairman Stan Hart opened the September meeting with 60 members and guests on hand. The business part of the meeting was given a new approach with an informal introduction of everyone present at the meeting. Committee chairmen were asked to describe their function in the section, which enlightened all members and guests. The section has progressive plans and has been expanding.

During the technical sessions Mrs. Elizabeth Ross, Aeroprojects Inc., spoke on "Statistics Applied to Ultrasonic Welding," and Dr. S. M. Free of SKF Laboratories with "Sampling for Chemical Analysis." Both sessions were well attended and included active audience participation.

For those who missed the Fifth Annual Symposium which was held in September, 1960, copies of the Transactions (100 pages) are available for $2.00. A few of the 1959 Transactions are also available for the same cost.

The Christmas party will be early this year, so make your reservations now for Dec. 2, at the Germantown Cricket Club.

Albert G. Dettore

PITTSBURGH . . . At our September dinner meeting, Edwin G. Olds, Carnegie Institute of Technology, was honored for his many contributions to ASQC in general, and for his meritorious work in the Pittsburgh section. Dr. Olds was the 1953 recipient of the "Brumbaugh Award," and in 1954 was presented the "Shewhart Medal." At the evening program, Charles R. Hicks, assistant dean of the School of Science, Education and Humanities, Purdue University, Lafayette, Ind., spoke on "Statistical Thinking for Quality Engineers." His presentation was both stimulating and thought-provoking.

Our section members report dynamic interest in QC by other activities, as evidenced when they attended the recent 9th annual meeting of the Standards Engineers Society and at dedication ceremonies of the new National Headquarters of the American Society for Metals. Participation of our members in these meetings shows our expanding sphere of influence and activity in other technical societies.

Chester R. Smith

PITTSFIELD . . . On Sept. 14, Leroy H. Lindgren, chief industrial engineer, Joy Manufacturing Co., Claremont, N.H., discussed the practical application of statistics in industry. He presented six problems and then called on his vast experience and gave the solution for each. Following his presentation a question and answer session was held. The meeting adjourned at 11 p.m.

On Dec. 7, Dr. Harry G. Romig, Operations Research, Inc., Los Angeles, Calif., will speak on "The Ethics of Professionalism within ASQC." His speech will be accompanied by a movie produced by Keuffel and Esser Co., on "How to Sell Quality."

Howard J. Greenslet

RICHMOND . . . "Effective Measurement of Quality Costs," was explained Sept. 30 by James V. Harrison, director of the School of Logistics, Ohio State University, Columbus, Ohio, during a dinner meeting at the Elks Country Club. He is in charge of an educational program now being conducted for USAF personnel at Wright-Patterson AFB, Ohio.

Mr. Harrison outlined three areas of measurement — failures, appraisals and prevention. He stated that an industrial QC program should cost between $500 and $1,000 per productive employee per year.

W. B. Smith, chairman, presided over the meeting and introduced newly-elected officers: vice chairman — D. A. Rhoda, Perfect Circle Corp., and secretary-treasurer — R. S. McLaughlin, AVCO Corp. Executive board members are B. E. Reynolds, USAF, junior past chairman; D. C. Hayward, Avco Corp., special assistant to the chairman; R. G. Jester, USA ordinance, publicity chairman, and H. F. Farmer, Avco Corp., membership chairman.

More than 30 QC engineers, managers and statisticians from Richmond, Hagerstown, Connersville and New Castle, attended the meeting.

On Dec. 15, the section will tour the Richmond Perfect Circle Plant.

R. S. McLaughlin

ROCHESTER . . . On Dec. 20, the section will hold a joint meeting with the IMC Industrial Engineering Society. This is the regular monthly meeting of the Rochester ASQC section and the Rochester Society for Quality Control. The technical sub-group of RSQC will meet Dec. 6, and the gaging and measurement subgroup will meet Jan. 3. The reliability sub-group will meet Dec. 12. All sub-group meetings are held in the Chamber of Commerce Bldg. in Rochester, N.Y. The next meeting of the Food and Allied Industries subgroup will be held Jan. 17.

A. D. Rickmers

ST. CHARLES . . . The first meeting of the fall season was held Sept. 20 with 70 members and guests present. Gayle W. McElrath, University of Minnesota, gave a very informative talk on "New Techniques in Quality Control." He pointed out that he had nothing completely new in the method of controlling quality but he did have some tools that should be used more if the presently used methods were to reap the best results. Communication, especially, was cited as important.

At the business meeting our education chairman, Robert Mink, announced that the first course this year would be a basic course in quality control.

A butt steak dinner was enjoyed by all.

Ellis Elder

SACRAMENTO . . . It has been reported, though not verified, that there was a sharp decline in gambling in the Reno area in November shortly after Charles Hirsch of the Las Vegas Casino "Golden Nugget," told this section about "Statistical Control of Casino Operations."

On Dec. 14, Henry Matosoff, Cannon Electric Co., will present "An Industrial Engineering Approach to Quality Control." The speaker's broad experience should provide all industry in the area with an insight to the management of quality control.

M. K. Walker

ST. LOUIS . . . Because of model changes at the new Chrysler plant, it was necessary to postpone the scheduled plant tour until October. Happily, the mystery guest speaker we had scheduled for October agreed to speak at the September meeting. Mr. Mystery turned out to be our own Arnold Braun of Carter Carburetor who spoke on "Quality Control and the Stock Market." Mr. Braun gave us several good tips on how to make money in the stock market, which this reporter refuses to pass along.

The St. Louis section furnished two speakers for the September meeting of the Steel Founders' Society of America which was held in St. Louis. Arnold G. Braun

Metals Technical Committee Publishes New QC Booklet

The ASQC Metals Technical Committee has published a "Training Sampler—Methods Used to Strengthen Quality Control Programs," to acquaint quality control people in the flat rolled area of the primary metals producing industries with methods which have been successfully employed by their contemporaries to strengthen existing QC programs.

Another principle objective, the introduction of an active and organized exchange of training ideas at the "working level" of QC, will be attained if readers of this booklet relate their ideas on training methods and/or problems which they have encountered to the ASQC Metals Technical Committee.

Limited copies of this publication are available from H. W. Williams, Quality Control Laboratory, Inland Steel Co., East Chicago, Ind.

Film Library Committee

This committee of the American Society for Quality Control is set up to make available on a rental basis films dealing with Quality Control that will be of benefit to the various sections and its members. These films can be rented from our Milwaukee Office on a twenty-four hour basis for $2.50 per reel. Generally the films will be of an educational and/or technical nature. Those desiring scheduling of the films on this basis should contact George R. Foster, Managing Editor, I.Q.C., Room 6185, Plankinton Building, Milwaukee 3, Wisconsin. The films available at the present time are:

Number MN-6621-A	PROCRESS CONTROL
Number MN-6621-B	ACCEPTANCE SAMPLING

It is also the duty of this committee to list for the benefit of the members other films which are not strictly of a technical nature and which, in most cases, advertise the various companies' products. Here one views both products in the course of being manufactured and at the same time sees the various applications of Quality Control. The films which have been so classified and the contacts for procurement are listed below:

Federal Products Corp. 1144 Eddy Street Providence, R. I.	GAGING FOR PROFIT, 38 min., 16mm, full color and sound film.
Optical Gaging Products, Inc. 26 Forbes Street Rochester 11, N.Y.	OPTICAL GAGING
Association Films, Inc. Broad at Elm Ridgefield, New Jersey	QUALITY CONTROL IN MODERN MERCHANDISING, general information film showing the care exercised in procuring raw materials and fabrication of same into finished products. Goods sold by J. C. Penney Co.
Methods Engineering Council Management Consultants 718 Wallace Avenue Pittsburgh 21, Pa.	FUNDAMENTALS OF QUALITY CONTROL, produced in conjunction with the York Corp. Action centers around production of compressor pistons and other parts and deals with distribution. Color and sound. Rental $18.
U. S. Steel Corporation 525 William Penn Place Pittsburgh 30, Pa.	THE GERM, a film of particular benefit to those interested in selling Quality Control from the overall standpoint. It depicts the hazards of steel manufacturing with emphasis on "Build It Right".
University Extension University of California Educational Film Sales Dept. Los Angeles 24, Calif.	INTRODUCTION TO WORK SAMPLING, 20 min., 16mm color and sound film with good basic approach to work sampling. The use of random sampling in obtaining any type of sample is explained.
University Extension University of California Educational Film Sales Dept. Los Angeles 24, Calif.	CONCRETE QUALITY CONTROL TESTS, 20 min., 16mm color and sound film of general quality control interest. Shows care used to control large quantities of cement. The tests demonstrated include the Slump, Kelly Ball, Air Volume, Compressive and Impact Hammer.
Department of the Navy Att'n: CDR R. C. Wing Bureau of Ships —Code 258-16 Washington 25, D.C.	ENVIRONMENTAL FACTORS AFFECTING RELIABILITY OF ELECTRONIC EQUIPMENT, SHIPS 5-56, 16mm black-and-white sound film explaining the need for and the means of testing for various environmental conditions.
Department of Mines and Technical Surveys Att'n: Dr. J. Visman Senior Scientific Officer 114th Street & 87th Avenue Edmonton, Alberta, Canada	QUALITY CONTROL IN THE MINING INDUSTRY, 20 min., 16mm., black-and-white sound film. The film is a case history of the application of acceptance sampling and statistical estimation for a coal washing operation. Rental $25.
Joanna Cotton Mills Att'n: Mr. Kelly Waits Joanna, S.C.	QUALITY GOOD AND BAD IN THE TEXTILE MILL, a show consisting of approximately 60 black-and-white and colored slides, 2" x 2", in glass-and-metal frames, synchronized with voice, incorporated on a standard 600-foot roll of magnetic tape. Examples of problems occurring in a textile mill are shown.
Standard Pressed Steel Co. Att'n: Mr. A. W. Scott, Advertising Dept. Jenkinton, Pa.	THE SEARCH FOR RELIABILITY, 16mm sound-and-color film, about 20 min. duration.
FOR THE COMMANDER; Ordnance Tank-Automotive Command Detroit Arsenal 28251 VanDyke Avenue Center Line, Mich. Att'n: ORDMC-IF-2	EVALUATION OF QUALITY CONTROL SYSTEMS, 16mm color-and-sound film, 23 min. General information film showing how the U.S. Army Ordnance Corps applies evaluation of its contractors' quality control systems as a major phase of the Ordnance Quality Assurance Program.

Mr. H. E. Marrows, Public Relations Western Electric Co., Inc. 195 Broadway New York 7, N.Y.	ENGINEERING NOTEBOOK, 26 min., color-and-sound, 16mm movie. Not strictly a quality control film but shows very clearly the need for quality in automated production. Reliability of product is stressed.
McGraw-Hill Book Co. 330 West 42nd Street New York 36, N.Y.	QUALITY CONTROL, Purchase only, 10-15 min., 16mm black-and-white, $70. Follow-up filmstrip $5. An elementary film on Quality Control. Covers variables in manufacturing and explains how controls help produce consistent quality and reduce scrap. Touches on setting of standards and use of statistical techniques. Illustrates the laws of probability and expectancy; also use of tables and control charts.
Hughes Aircraft Co. Att'n: C. W. Short Bldg. 6, Room D1005E Culver City, Calif.	A LIFE IN YOUR HANDS, 16mm, color, sound, 22 minutes. In military electronics manufacturing, where the failure of two parts out of every 10,000 tested is a serious problem, Hughes Aircraft Company has developed a new approach to reliability. It calls for close cooperation and understanding between HAC and its more than 7,000 suppliers. In the film, this theme is expanded by the device of three vendors who are called to Culver City to discuss problems that have developed during the use of their products.
Hughes Aircraft Co. Att'n: C. W. Short Bldg. 6, Room D1005E Culver City, Calif.	THE PRIME DIMENSION, 16mm, color, sound, 24 minutes. Visible only to the audience, an imaginary ADC Colonel is brought to the Hughes Tucson facility. He joins a conducted plant tour and sees the exacting care and rigorous testing synonymous with Falcon production. His faith in the reliability of the missile is complete when later he scores a dramatic aerial hit during a test flight.

This listing of films does not constitute endorsement by ASQC of the films or products of the companies involved, but merely represents a catalog of films which the Library Committee has viewed and is making available to IQC readers strictly on an information basis.

5th ASQC Workshop-Seminar

MANAGEMENT OF QUALITY CONTROL

January 16 - 17 - 18, 1961

Penn Sheraton Hotel, Pittsburg, Pa.

What is the purpose of the workshop seminar? To explore in depth, tested methods of increasing the effectiveness of the quality control program in an industrial plant.

For whom is the program planned? For present and prospective Quality Managers. It is expected that the applicant will have reasonable familiarity with such standard texts as Grant, Feigenbaum, and Juran. To benefit properly from the seminar, the applicant should have a minimum of several years experience with major responsibility for quality.

Registrants will be sent study materials and case studies prior to the conference. Registration is limited to 75 persons and is complete only on receipt of the registration fee of $125 for non-members, $100 for members, which includes the cost of three lunches.

Your Registration will be acknowledged. A room reservation card for the Penn Sheraton Hotel will be enclosed with the acknowledgment.

ASQC Institute
Paul C. Clifford, Director

Fifth ASQC Workshop - Seminar
ASQC Institute
161 West Wisconsin Avenue
Milwaukee 3, Wisconsin

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Company .....

Address .....

City.....**Zone No.** ....**State**.....

NOTE: Additional registrations may be made by attaching a list to this coupon. Please include necessary information for each registrant.

spoke on "Fundamentals of Quality Control" and Joe Movshin discussed "Statistical Methods for the Jobbing Foundry."

W. W. Paris

ST. PETERSBURG-TAMPA . . . On Sept. 12, Eugene West, product assurance director, Radiation, Inc., Melbourne, Fla., braved the hazardous highway conditions left by killer hurricane Donna and drove to St. Petersburg from Melbourne. His topic, "Incoming Inspection as a Reliability Tool," was thoroughly enjoyed by 30 members and guests. An informal social followed the talk.

Harold L. Goldberg

SAN ANTONIO . . . The section held its first meeting of the new season Sept. 20 at the Granata Hotel.

John L. Folks, operations research manager, Texas Instruments, Inc., Dallas, Texas, gave a very enlightening paper on "Experimental Error — What Is It?" The paper was centered around the vital importance of experiment of design in resolving problems.

This is the third year that Texas sections have arranged circuit tours in scheduling speakers for the season. Program chairmen have arranged for eight nationally known speakers to visit Texas sections September through May 1961.

R. W. Worrick

SAN BERNARDINO . . . The first meeting was held Sept. 20 at the Mural House in Ontario, Calif. An excellent turnout was present for "Aerojet Night." Verne R. Boulton, Aerojet, Sacramento, spoke on "Some Effects of Measurement Accuracy on Testing Costs."

G. A. Williams

Dr. Grant I. Butterbaugh

Dr. Grant I. Butterbaugh, 66, a founding member of the Seattle section, had a fatal heart attack on Sept. 21. He collapsed at the wheel of his car while on a pleasure trip with his wife, Laura.

Dr. Butterbaugh was a member of the staff and faculty of the Universitiy of Washington since 1928. For seven years he had edited *The International Journal of Abstracts on Statistical Methods in Industry*, published in The Hague. His annotated bibliography on statistical quality control has been published in 17 countries and he has been considered one of the leading scholars in statistics and quality control.

Dr. Butterbaugh

Dr. Butterbaugh had traveled widely in connection with his work, most recently having taken part in a conference of his regional editors in Tokyo last summer. The Butterbaughs included the conference in an around-the-world trip.

Dr. Butterbaugh was born in Merrill, Wis. He received his B. A. from the University of Wisconsin, his Master's degree from the University of Washington, and was awarded his Ph.D. from the University of Chicago in 1942.

Dr. Butterbaugh was a Fellow of ASQC, the ASA, and the American Association for the Advancement of Science. He was also a member of Beta Gamma Sigma, business-administration honorary fraterity and Beta Alpha Psi, accounting fraternity.

Dr. Butterbaugh was chairman of an ASA committee on audio-visual aids in statistics. He met with this committee at Stanford University in August.

Dr. Butterbaugh's wife, Laura, is his only survivor.

The Seattle section and the Society lost a good friend and colleague.

SAN DIEGO . . . On Sept. 12, our regular dinner meeting was held at the Sands Hotel. A greater crowd than was expected turned out, much to the delight of all.

Guest speaker was Donald P. Germeraad, chief engineering test pilot, Convair SD Division, General Dynamics Corporation.

Mr. Germeraad covered the key points of activities undertaken by the Institute of Aeronautical Sciences and then proceeded to discuss the humorous, as well as the serious aspects, of how an engineering test pilot "lives" with "his" airplane during the manufacturing process.

A novel movie produced by Scandinavian Airway System, depicting the evolution of flight from DiVinci's time through the present day of the pure jet, was shown as part of the presentation.

A program with special appeal for our more adventuresome members is planned for the meeting Dec. 12. Charles J. Hirsch, Golden Nugget Casino, Las Vegas, Nevada, will speak on "Statistical Control in Gambling Casino Operations." We are looking forward to a large turnout for this treatise on "To Have or Have Not."

L. I. Fredrickson

SAN FRANCISCO . . . At the September meeting, D. Allan, metallurgical statistical analyst, American Iron and Steel Institute, spoke on developing industry standards by statistical methods. He reviewed some of the experiences of the Institute in the field of industrial standardization.

On Dec. 12, the section will depart from the usual procedure of a single expert speaker and discussion period. Instead, three experts from the Bay Area who have developed effective and practical control techniques will present their accomplishments for possible applications in other Bay Area industries.

Speakers and subjects are Jay Keat, American Can Company — "Dimensional Control of Seams in Can Welding"; Howard Heap, United Air Lines — "Take a Second Look at Your Measuring Devices," and John Ogden, Lenkurt Electric Company—"Cumulative Tolerances."

M. R. Hubbard

SOUTH TEXAS . . . The section sponsored an EVOP course in Houston Sept. 1. It was considered a success by all participants.

During our September dinner meeting Dr. Leroy Folks, Texas Instruments, Inc., brought us up to date on "Experimental Error — What Is It?" This meeting was preceded by a very informative training session conducted by Lewis M. Buttery of Monsanto Chemical Corporation.

Ed Franklin

SOUTHERN CONNECTICUT . . . The first meeting of the 1960-61 season was a dinner meeting with the Joint Engineering Council at Pitney-Bowes in Stamford, Conn. "The Excitement and Romance of Engineering," was the subject of a talk by A. H. Morgan, president of Electronic Controls, Inc.

Future meetings will include such subjects as vendor-vendee relations, metrology and QC in cosmetics (for Ladies' Night). There will be no meeting in December.

Robert E. Kleid

SYRACUSE . . . On Sept. 20, a joint dinner meeting of the section with the Onondaga County Mathematics Teachers Association was held at Dellomartes Restaurant. William Golomski of H. J. Mayer & Sons, Inc., Chicago, Ill., addressed the group with a very interesting talk which stressed the importance of mathematics, particularly statistical analysis, in secondary schools.

Two QC courses were started Sept. 19 in Syracuse Central Technical high school through the cooperation of Syracuse section ASQC. "Applied Techniques of Statistical QC," is being taught by Larry Scimone of Carrier Corp., and "Applied Industrial Statistics, Part II, is taught by Ken Divers of Brown-Lipe Chapin. Both instructors are members of the Syracuse section ASQC.

Lee Huyler

TOLEDO . . . The Sept. 1 Get Acquainted Night proved to be just that, with members and visitors exchanging vacation experiences, fish stories, etc, before dinner

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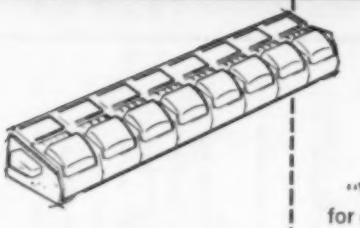

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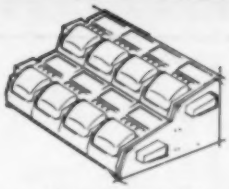

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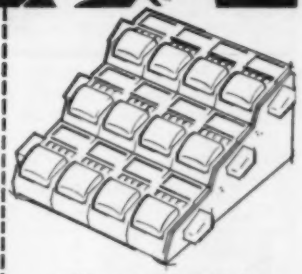

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SECTION CALENDAR (DECEMBER 1 TO JANUARY 10)

SECTION	DATE	PLACE	TIME	SUBJECT	SPEAKER
Akron-Canton	Dec. 15	Iacomini's	8:00 p.m.	Reliability Concepts As Applied to Military and Commercial Products	Dr. G. Ronald Herd, Booz-Allen Applied Research, Inc.
Albuquerque	Jan. 9	To be announced	....	Management of Quality and Reliability Controls	Robert L. Storer, Solid Propulsion Operation, Rocketdyne, McGregor, Texas
Allentown-Bethlehem	Dec. 14	Hotel Traylor, Allentown, Pa.	8:00	Incoming Inspection	To be announced
Baltimore	Dec. 20	Baltimore Memorial Stadium	8:15	QC & Operations Research	Dr. F. E. Grubbs, Ballistic Research Laboratory, Aberdeen Proving Ground, Md.
Battle Creek-Kalamazoo	Dec. 15	American Legion Clubhouse, Battle Creek, Mich.	7:00	Budgeting the Cost of Acceptable Quality (Joint Meeting with Lansing, Mich., NAA)	Russell Brown, Budget Control, Dana Corp.
Boston	Dec. 8	MIT Faculty Club	8:00	Production Line Experimentation	Frank Caplan, Jr., Westinghouse Corp., Blairsville, Pa.
	Jan. 12	MIT Faculty Club	8:00	What Does a Production Manager Expect from QC	Bruce W. Atchinson, Jr., Stanley Tools, New Britain, Conn.
Merrimac Valley Sub-Section	Dec. 1	Yankee Doodle Restaurant	....	QC in the Electronic Job Shop	Francis B. Kilduff, Jr., Instrument Development Laboratory
	Jan. 5	Yankee Doodle Restaurant	....	Quality Organization	Herbert R. Erickson, Borden Chemical Co.
Chattanooga	Dec. 13	Wimberly Inn	6:30	Round Table Discussion of QC	Membership
Chicago					
Cleveland	Dec. 2	Cleveland Engineering & Scientific Center	7:45	Factorials Are Good to Eat (Ladies Night)	Miss Mavis Carroll, General Foods Corp., Tarrytown, N. Y.
Columbus	Dec. 15	Ohio State University Union	6:00	Machine Capabilities (Joint meeting with AIIE)	Ralph Nottingham, North Electric Co., Galion, Ohio
	Jan. 4	Broad St. Christian Church, Columbus, Ohio	6:30	Metallurgical QC (Joint Dinner Meeting with ASM)	D. H. W. Allan, American Iron and Steel Institute, N. Y.
Corning-Elmira	Dec. 13	Corning Country Club	8:00	The Story of the Cutting Edge	Presentation by DoALL Co., Des Plaines, Ill.
Cumberland	Dec. 6	Ali Khan Shrine Club	6:30	Designed Experiments to Reduce Testing Costs	J. A. Davies, Receiving Tube Department, General Electric Co., Owensboro, Ky.
Dallas-Fort Worth	Dec. 8	Club Southwest	8:00	Management Night	
Delaware	Dec. 1	Lord de la Warr Hotel	7:00	Operations Research	Dr. Max Astrachan, Rand Co., Santa Monica, Calif.
Greater Detroit	Dec. 19	Hoover Ball & Bearing Co., Ann Arbor, Mich.	....	Hoover Quality—A Way of Life	Dale Cue, Hoover Ball & Bearing Co., Ann Arbor, Mich.
Greater Muskegon	Dec. 9	Spring Lake Country Club	6:30	To be announced	John G. Rutherford, Lear Inc., Grand Rapids, Mich.
Hamilton-Middletown	Dec. 7	Student Center, Miami University, Oxford, Ohio	6:30	The Story of the Cutting Edge	Presentation by DoALL Co., Des Plaines, Ill.
Harrisburg	Dec. 7	VFW, York, Pa.	6:30	Problems and Use of Statistics	Michael A. O'Hanlon, Jr., AMP, Inc., Carlisle, Pa.
	Jan. 4	Arcadia Cafe, Lancaster, Pa.	6:30	Operations Research (Joint meeting with ACS)	
Hartford	Dec. 13	Nutmegger House	6:30	Fastener Reliability	Paul Shuttleworth, Standard Pressed Steel Corp.
Indianapolis	Dec. 13	Butler University	7:30	Receiving Inspection Capability Studies In Process Controls	J. Dyer, Chrysler Corp. M. Ransom, Cummins Diesel G. Blackburn, Eli Lilly
					(Members' Night)
Kansas City	Dec. 15	Lantern Restaurant	7:00	Confidence Intervals	R. D. Summers, Bendix Aviation Corp. Kansas City, Mo.
Lexington	Dec. 15	Officers' Open Mess, Lexington Signal Depot	7:00	Relations and Inter-Relations in QC	Dr. A. W. Wortham, Texas Instruments, Dallas, Texas
Lima	Dec. 6	Clemans Bldg.	6:30	The Story of the Cutting Edge	Presentation by DoALL Co., Des Plaines, Ill.
	Jan. 10	Superior Tube Co., Wapakoneta, Ohio	7:30	A Dramatization—Sampling Inspection	D. C. Fultz, Ford Motor Co., Detroit, Mich.
Los Angeles	Dec. 14	IAS Bldg.	7:00	The Marquardt Corp. Panel Discussion Management View of Quality Assurance Quality Assurance in the Power System Division	H. E. Frye, panel chairman Roy Marquardt, president D. L. Walters, vice pres., Power System Group
Metropolitan	Dec. 3	Princeton, N.J.	9:30 a.m.	16th Annual All Day Conference	Various
Mid-Hudson	Dec. 6	Hotel DiPrima, Highland, N.Y.	8:00 p.m.	How to Sell Your Ideas	Jerome Barnum
	Jan. 3	Hotel DiPrima, Highland, N.Y.	8:00	Comparative Quality Measurements on Dissimilar Products	John Crowley, IBM Corp., Poughkeepsie, N. Y.
Milwaukee	Dec. 12	To be announced	6:30	Ladies Night	Entertainment
Minnesota	Dec. 6	Ford Motor Co.	2:30	Plant tour	.....
	Jan. 10	Holiday Lodge	6:30	Acceptance Sampling & New Life Test	Milton Sobel, Statistics Department, University of Minnesota, St. Paul, Minn.
Montreal	Dec. 7	CIL Bldg.	8:15	Possible Solutions for Some Problems in Communication	D. Arthurs, Sir George Williams University Montreal
Northeast Tennessee	Dec. 13	Kingsport, Tenn.	6:00	Statistical Approach for Improving the Reliability of a Component	Nicholas P. Demos, General Electric Co., Schenectady, N. Y.
Parkersburg	Dec. 14	Chancellor Hotel	7:30	Atomic Radiation Uses in QC	C. B. Moore, duPont Engineering Department
Philadelphia	Dec. 2	Germantown Cricket Club	6:15	Christmas Party	To be announced
Pittsburgh	Dec. 13	Downtown YWCA	6:30	To be announced	R. B. Murphy, Bell Telephone Laboratories, New York, N. Y.
Pittsfield	Dec. 7	Stanley Club	8:00	Ethics of Professionalism Within ASQC	Dr. Harry G. Romig, Operations Research, Inc. Los Angeles, Calif.
Rochester	Dec. 20	Chamber of Commerce Bldg.	6:15	To be announced	Gayle McElrath, Department of Mechanical Engineering, University of Minnesota, St. Paul, Minn.
St. Charles	Dec. 20	Tally-Ho, West Chicago	6:30	Integration of QC	Ted Krueger, Zenith Radio Corp., Chicago, Ill.
Sacramento	Dec. 14	Sacramento	6:00	Industrial Engineering in QC	H. Matosoff, Cannon Electric Co., Pacoima, Calif.
St. Louis	Dec. 16	Golden Fried Chicken Loaf	8:00	Ladies Night	Annual Party

St. Petersburg-Tampa	Dec. 13	Schlitz Brewing Co., Tampa, Fla.	8:00	Guided plant tour	Delmore Ehlers, Schlitz Brewing Co., Tampa, Fla.
San Bernardino	Dec. 13	Mural House, Ontario, Calif.	7:00	Latest AF Quality Requirements of Industry	Colonel G. F. Keeling, Headquarters, Western Contract Region, Mira Loma, Calif.
San Diego	Dec. 12	Sands Hotel, Highway 392	7:00	Statistical Control in Gambling Casino Operations	Charles J. Hirsch, Golden Nugget Casino, Las Vegas, Nevada
San Francisco	Dec. 12	Mitch's Restaurant, Oakland, Calif.	8:00	Dimensional Control of Seams in Can Manufacturing	Jay Keat, American Can Co.
				Take a Second Look at Your Measuring Devices	Howard Heap, United Air Lines, Palo Alto, Calif.
Seattle	Dec. 2	Engineers' Club, Arctic Bldg.	....	Cumulative Tolerances	John Ogden, Lenkurt Electric Co., San Carlos, Calif.
				The Place of QC and Testing Engineers in Reliability Programs (Joint dinner meeting with Society for Non-Destructive Testing)	Dr. Leslie W. Ball, Aero Division, Boeing Airplane Co., Seattle, Wash.
Syracuse	Dec. 13	To be announced	6:30	Vendor Consumer Relations	Andrew P. Sterglon, Corning Glass Works, Corning, N. Y.
Toledo	Dec. 3	EST Club Rooms	8:00	Christmas Party	All fun, no work
	Jan. 5	EST Club Rooms	6:30	IBM 650 Computer and Its Application to QC	King E. Forry, Owens-Illinois Co., Toledo, Ohio
Tennessee	Dec. 15	Knoxville	8:00	Making Control Charts Work	H. A. Lasater, Union Carbide Co., Oak Ridge, Tenn.
Toronto	Dec. 7	CGE	8:00	Foundry Application of Quality Control	R. W. Gardener, Dearborn Iron Foundry, Ford Motor Co., Dearborn, Mich.
	Jan. 1	CGE	8:00	Bulk Sampling Problems—What to Do	R. S. Bingham, Carborundum Co., Niagara Falls, N. Y.
Western Massachusetts	Dec. 13	Shelton Hotel, Springfield, Mass.	6:30	A Practical Application of Designed Experiments on Manufacturing Processes	Ken S. Stephens, Western Electric Co., Allentown, Pa.
Wichita	Dec. 6	Beech Employees' Club Cafeteria	6:30	Gaging	J. Rumburger, Bendix Corp., Kansas City, Mo.
Windsor	Dec. 14	Marios Restaurant	6:30	Children's Christmas Party	Santa Claus, North Pole
Worcester	Dec. 6	To be announced	7:00	Frequency Distribution Analysis Sheet	Ervin Taylor, The Martin Co., Baltimore, Md.
Youngstown	Dec. 1	Astoria Cafe	6:30	Fundamentals of Linear Programming	Fred E. Kindig, Westinghouse Corp., Pittsburgh, Pa.
	Dec. 15	King's Table Restaurant	6:30	Christmas Party	.....
	Jan. 5	Astoria Cafe	6:30	The QC Engineering Job	Stephen T. White, General Electric Co., DeKalb, Ill.

was served at the Engineering Societies of Toledo Club Rooms. William Rogers of Johns-Manville Fibre Glass, Inc., was a most interesting speaker and the J-M film "Modern Quality Control" was enjoyed by everyone.

The December meeting, always devoted to a Christmas party with the spouses, is all arranged for the Club Rooms Dec. 3, beginning with a dinner at 6 p.m. A large attendance is expected.

King E. Forry, senior systems analyst, office of methods and procedures, Owens-Illinois Co., Toledo, Ohio, is scheduled to speak at our Jan. 5 dinner meeting at the Club Rooms. His subject will be "IBM 650 Computer And Its Applications in Quality Control," and the moderator for the evening will be Theodore R. Meyer, past Toledo chairman and QC director at Kimball Glass Company.

Carwin L. Elwick

TENNESSEE . . . The first in a series of QC training sessions was held at the September meeting. The purpose of these sessions is to familiarize area industries in the use of Quality Control. Preceding the training session, Richard Browning, Southern Gage Co., spoke on "Quality Control Problems at a Gage Manufacturing Plant."

J. P. Reavis

TORONTO . . . Our first meeting was held Sept. 14 at the Canadian General Electric Co., 214 King St. W. Our new chairman, Jack Boardman, welcomed members and visitors to the well attended meeting. William Edgley, Manufacturing Development, Lamp Dept., CGE Co., explained "What Management Expects of Quality Control."

On Sept. 21, members and friends enjoyed a tour through Hinde & Dauche Ltd., Toronto, manufacturers of corrigated cartons.

Our program committee has a well rounded series of programs scheduled for this season with highly qualified speakers and interesting plant tours.

George Culver

UTICA . . . On Sept. 15, the first dinner meeting was held in the Hotel Hamilton. An exceptional talk was delivered by M. J. Marcus, manager of maintainability engineering, IBM, Owego, N.Y. His talk was entitled "Organization for Maintainability Measurement and Assurance." The maintainability problem was placed in the perspective of the last decade of engineering technology. Management techniques through systematic approaches for maintainability control were presented and discussed.

D. F. Yeaton

VANDENBERG-SANTA MARIA . . . Dr. Otto Berger, Lockheed Missiles and Space Division, presented "Quality Assurance in Research and Development," at our first meeting Sept. 26. The film, "Discoverer Program," was also shown.

V. E. Johnson

WESTERN MASSACHUSETTS . . . On Tuesday evening, Dec. 13, in the Cotillion Room of the Hotel Shelton, Springfield, Mass., Ken S. Stephens, chief, QC engineering department, Western Electric Co., Allentown, Pa., will speak on "Practical Application of Designed Experiments on Manufacturing Processes." Mr. Stephens will be introduced by David M. McIntosh, Jr., manager of manufacturing, Chapman Valve Co., a subsidiary of the Crane Co., and through the use of slides will sketch the planning conducting, analyzing, and interpreting, as well as further experimenting that is usually involved in an experimental program.

Mr. Stephens was the 1959-60 chairman of the Allentown-Bethlehem section, and is currently serving as a member of the National Education and Training Committee, ASQC. He is secretary of the 1961 National Convention. Dinner at 6:30 p.m., speech at 8 p.m.

The annual outing which marked the beginning of

the season was successfully held at Strathmore Park, Woronoco, Mass., on Sept. 13.

Our speaker for the meeting Jan. 10 will be Warren R. Purcell, QC director, Raytheon Co., Waltham, Mass. The subject to be covered is "Quality Cost Control."

Alan J. Donnelly

WICHITA . . . The September section meeting was very interesting and educational. M. F. Wilson, QC director, Collins Radio Co., presented a very timely talk on "QC Techniques Used in Short Run Production."

The 15th Midwest Conference Planning Committee has engaged all speakers and moderators, sent all papers to the printer, and was in the last stages of completing Conference arrangements. Early interest is very good. Attendance is expected to exceed 250.

J. Rumburger, our December speaker, is considered an expert on gaging. Gaging is a vital part of QC and attendance at this meeting is expected to be high.

Howard K. Mitchell

WINDSOR . . . Bonjour Monsieur — The H. J. Heinz Co. Ltd. of Leamington, Ont., is becoming more of a tourist attraction as well as a large modern food processing plant. Of the 14,000 visitors to the plant this year, the Windsor section members and wives added to this total by 50.

Mr. Marshall welcomed the group to the plant and Mr. J. Strong was the guiding inspiration for the group. Plant visitors are given a guided tour through the processing, cooking, laboratories, packing, and the many other areas necessary to produce a variety of food items for a competitive market. Prime concern is quality and a consistent product from the field to the container. Each guest was provided with a gift package of products from our host, the H. J. Heinz Co.

A. J. Hewitt

WORCESTER . . . On Sept. 15, the monthly meeting of the Worcester section was held at Worcester Polytechnic Institute. Following the dinner, Chester Gadzinski, Raytheon Co., discussed how to plan, organize and measure work for incoming material control program. Mr. Gadzinski used slides to supplement his talk and it proved very interesting. A short discussion period was held following the talk.

On Dec. 8, Ervin Taylor, Martin Co., will speak to the Worcester section on "Frequency Distribution Analysis Sheet."

Daniel J. Burda

YOUNGSTOWN . . . Ladies will be guests at the Smorgasbord Christmas Party 6:30 p.m. Dec. 15 at the King's Table Restaurant.

William Lisby, ASQC member and engineer with General Motors Co., will entertain with "Sleight of Hand and Ventriloquism."

Charles T. Wierbaugh

Professional Development Note

Samuel A. Oliva

Samuel A. Oliva has been named general manager of the Electronics Division of Richard D. Brew and Co., Inc., Concord, N.H.

Mr. Oliva was formerly manager of the Dictaphone Corporation plant in Concord. He had been with Dictaphone for 18 years.

According to Richard D. Brew, president of the New Hampshire scientific manufacturing organization, Mr. Oliva's extensive manufacturing experience will provide the Electronics Division with the leadership demanded by the competitive position it has assumed as a major producer of electronic delay lines for use in computers, radar systems and missile coding systems.

Mr. Oliva is a member of ASQC and the Society of Plastics Engineers.

Significant Differences

. . . Akron-Canton — **Bob Baker,** an enrolled student, has just completed a three month course in business statistics at Tri-State College.

. . . Albuquerque — **G. O. Hawley,** QC supervisor, Sandia Corp., will present a paper at the Seventh National Symposium on Reliability and Quality Control in Philadelphia, Pa., Jan. 9-11. The paper is co-authored by Mr. Hawley and **Dr. Bernard Ostle,** professor, Arizona State University, Tempe, Arizona.

. . . Allentown-Bethlehem — **Ken Stephens,** our immediate past chairman, is currently teaching a class in "Statistics applied to the physical sciences," at Rutgers • The State University, New Brunswick, N.J.

. . . Baltimore — **H. Ellner,** co-chairman, program committee, and section treasurer, has received a commendation from the office of the Assistant Secretary of Defense for his excellent work in preparing the Department of Defense Quality Control and Reliability Handbook H109.

. . . Boston — Personnel changes include **Ted Brownrigg** — from Datamatic to Dunn Engineering Associates; **Robert G. Fitzgibbons** — from reliability engineer to QC section manager, Raytheon, Wayland Laboratory; **John E. Kane** — from QC manager, Bolta Products, to QC manager, Vernon Plastics Corp.; **Neil M. Leary** — from QC analyst to quality assurance engineer, Raytheon; **Karl M. Mueller** — from Montreal to senior test engineer, National Co., Malden, Mass.; and **David Ross** — from Columbus, Ohio.

. . . Corning — **John Gailey,** Corning Glass Works, section secretary, has been appointed QC supervisor, Vycok Glass Plant, Corning, N.Y.

Dick Melsheimer, Corning Glass Works, has joined the "B & C" factory as QC engineer.

Dick Gibson has been transferred from the Harrodsburg, Ky., optical plant to the Corhart Bonded Refractories plant in Corning. Welcome back!

Donald Ludlum has been appointed quality auditor for all of the Corning Glass Works plants.

. . . Dallas-Fort Worth — **William E. Smith** has accepted a position with Lockheed Missile Division, Sunnyvale, California.

We are happy to have **D. R. Mabry** back in our membership. Mr. Mabry was gone for some time last year.

The program for the section's Sixth Annual Symposium to be held in March, 1961, is getting well underway.

. . . Delaware — For the purpose of increasing interest in statistics and mathematics, a fund for a $50 savings bond has been set aside for the next three years.

Each year one of these bonds will be awarded to the outstanding senior for excellence in mathematics or statistics at the University of Delaware. This year's recipient was **Joseph Yellin** of Wilmington, Dela., for mathematics.

. . . Hamilton-Middletown — At the first meeting of the season our past chairman, **John Bemesderfer,** Hamilton, Ohio, was presented with an appropriately inscribed gavel. He was commended for his fine past work any very successful 1959-60 year by **DuWayne Carlson,** section chairman. He was also presented with an initialed, tan attache case.

. . . Indianapolis—Congratulations are in order for **Dr. Charles Hicks,** who has been promoted to assistant dean of the School of Science, Education and Humanities of Purdue University, Lafayette, Ind. It could not have happened to a better guy. We all wish him the best of luck in his new post.

. . . Kansas City—The section welcomes **Robert Schin** and **John Tepper,** transfers from the Allentown-Bethlehem section. Both men are with Western Electric.

. . . Lexington—**John Sisto,** associate mathematician, IBM, is teaching the 12 week course in basic statistics sponsored by the section at the Lafayette Vocational

School. Fourteen students started the 12 week course Sept. 20.

. . . Los Angeles—**R. Calvert Haws** has taken over as vice chairman of the Inspection technical committee. Due to the illness of Mrs. Ray Primmer, Ray has had to curtail his many activities such as running the Inspection Committee, *Plus & Minus* editor, and scouting work.

Congratulations are extended to **Lou Buhler,** membership chairman, on his new position as quality manager, Vard Division, Royal Industries. He was formerly with Clary Corp.

J. D. Blakely, section secretary, has become supervisor of quality assurance at Autonetics Division of North American Aviation Corp. He was formerly with Firestone Tire & Rubber.

. . . Metropolitan—**Robert L. Schwerin** has been appointed QC manager of the Paramus, N.J., plant of the ACF Industries electronics division.

. . . Mexico City—Ing. **Enrique Gonzales Lara,** senior member, and Ing. **Antonio Diaz Chavez,** member, have been appointed to the rank of General in the Mexican Army.

Miss **Estela B. Yarza** has returned from a one year trip during which she studied and worked in England and Germany.

. . . Minnesota—The section welcomes **Jim Hopkins** who transferred to us from the Kansas City section. Mr. Hopkins was a QC engineer with Westinghouse Corp., and is now a QC engineer with Remington Rand Univac in St. Paul.

. . . New Hampshire—**George W. DeLorie,** quality assurance manager, Richard D. Brew & Co., Concord, N.H., is now supervisor, vendor assurance with Sanders Associates, Inc., Nashua, N.H. Until recently, Sanders was predominently a research and development organization. Recently, high production contracts have been awarded this company, necessitating vendor assurance as part of the quality control program.

James E. Tarrant, Jr., formerly assistant to the QC director, is now chief inspector with New Hampshire Ball Bearings, Inc., Peterborough, N.H.

. . . Northeast Tennessee—The June issue of *Industrial and Engineering Chemistry* contains a paper by **Carl L. Wilson** entitled "A Designed Experiment in Producing a New Chemical in Existing Equipment."

J. W. Thompson, former section member, is now employed by Electro-Tech Corp., Blacksburg, Va.

Dr. Hubert Hill, past section chairman, has been designated chairman of the Quality Control Clinic to be held at the University of Tennessee in March.

Blue Ridge Glass Co., Johnson City, Tenn., is now represented in the section by five new members who were welcomed at the last section meeting.

In November, this section will hold a joint meeting in Marion, Va., with the Virginia section of the American Statistical Society.

. . . Omaha-Lincoln—**E. P. Murphy,** 1959-60 section chairman, is now superintendent of Division A, Goodyear Tire & Rubber Co., Los Angeles, Calif.

W. S. Jolitz, past section chairman, is now QC manager, and **L. E. Westmoreland** is now QC engineer at the Lincoln Division, Goodyear Tire & Rubber Co.

. . . Philadelphia—Section secretary **George Nimick** has been transferred from Philadelphia to Pittsburgh with Gulf Oil Co. Picking up his duties as secretary is **Reese Davis,** Taylor Fibre Co., who was appointed by chairman **Stan Hart.**

Neville W. James is now with International Resistance Co., Philadelphia, Pa., as reliability-quality engineer.

. . . Pittsburgh—We were pleased to learn that **Peter Du Fresne,** Latrobe Steel, was recently promoted to supervisor of standards and procedures.

We recently acquired two new members—**Robert E. St. Pierre,** Pillsbury Co., and **Robert F. O'Connor,** Veeder-Root Co.

. . . Richmond, Va.—**Robert C. Murrell** is now QC director, Melpar, Inc., Falls Church, Va.

. . . St. Charles—Congratulations to **Earl Eglie,** Zenith Corp., and best wishes in your new duties as QC manager, Plant 5, which produces the Zenith Stereo line.

The first class of the fall educational program started Sept. 29, at the St. Charles High School.

. . . Sacramento—A pre-meeting clinic was started in October by **E. A. Polgar** of Aerojet General Corp. Judging by the interest in his "Do It Yourself Sampling Plans," the clinic is here to stay.

. . . St. Louis—**J. O. Brookshire** has left the Aero Chart and Information Center, USAF, at St. Louis to work for NASA at Huntsville, Ala.

. . . San Antonio—**R. W. Worrick,** section director, recently completed a three week course in advanced statistical analysis at Hq. AMC, Dayton, Ohio. This course was made available by the Air Force Institute of Technology in cooperation with Ohio State University.

. . . San Francisco—**Delmar E. Loewe** has left the Quality Control Laboratory, Carnation Co., and is now section leader, hazards control department, Lawrence Radiation Laboratory.

. . . Southern Connecticut—**Howard A. Rosenberg** has joined Zell Products Corp., Norwalk, Conn., as QC manager.

. . . Toronto—New officers are: chairman — **J. E. Boardman,** Honeywell Control Ltd., Leaside, Ont.; vice chairman—**J. D. Butler,** IBM, Toronto, Ont.; secretary—**S. Brodsky,** Canadian General Electric Co., Toronto, Ont.; treasurer—**C. S. Argyle,** Long Manufacturing Co., Oakville, Ont., and junior past chairman—**R. de la Roso,** Acme Carbon & Ribbon.

. . . Worcester—Two of our section members are conducting QC courses at Worcester Junior College. **Arthur Pingalore** is teaching the fundamental course and **Axel Sternlof** is teaching the advanced course.

16th Annual Princeton Conference

On Dec. 3, the 16th Annual Conference, Princeton, N.J., will be co-sponsored by the ASQC Metropolitan section and the ASA Physical and Engineering Sciences section under the chairmanship of Thomas E. Shahnazarian, quality engineer, General Tire and Rubber Co., Akron, Ohio.

The luncheon speaker will be Joseph A. Gwyer, Library of Congress, who will speak on "Quality Control in the USSR."

The program will include Survey Sampling by Dr. W. H. Williams, Bell Telephone Laboratories; Sampling Designs by Dr. Mervin Muller, IBM; Acceptance Sampling by Dr. Gerald Lieberman, Columbia University; Experimentation by Cuthbert Daniel, Consultant, and Allocation Problem by Cyrus Derman, Columbia University.

Automotive Division Conference

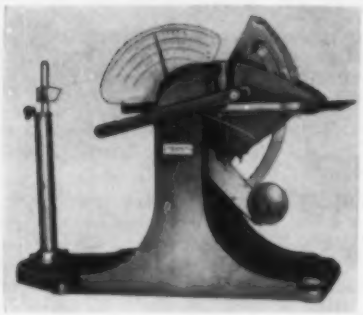
The Annual Automotive Division Conference will be held Feb. 11, at the Rackham Memorial Building, 100 Farnsworth Ave., Detroit 2, Mich.

According to B. N. Westover, conference chairman, the theme of this conference will be "reliability."

For information and registration, contact Steve Adams, 18469 Dolores Ave., Lathrup Village, Mich.

What's New?

ROY A. WYLIE, *Editor*
Ampex Corporation



P-12-1—With the Beach Puncture Tester, puncture resistance tests can be made on fiberboard, wall board, vulcanized fiber, thin plywood, very heavy paper and similar materials. In specialized cases it may be used on asbestos board, plastic film and rubber sheeting. Measurements obtained from the Beach Puncture Tester are used to determine the ability of a material to meet specifications requirements and for rejecting grades unfit for their intended purposes. The data is also useful in evaluating various elements of design, material, and fabrication and their relationship to serviceability. Normal scale reading is from 0 to 1280 inch ounces per inch of tear. For lighter materials, a secondary release can be used which reduces the pendulum energy to slightly less than one-third. The tester meets the American Society of Testing Materials (ASTM) and Technical Association of the Pulp & Paper Industry (TAPPI) Standards.

* * *

P-12-2—Quality control of beverages, oil, sugar, saline and glycerine solutions and other liquid products can be improved and simplified with the Waters Differential Recording Refractometer. The refractive index change of a liquid mixture is a very sensitive indication of a change in the quality of the mixture. Measurement of these small changes have been made practicable by the new instrument which measures index of refraction changes as small as 0.0000007 index of refraction units, yet requires no more space than a strip chart recorder. The principle of the instrument is measurement of the amount a light beam is bent when passed through a liquid sample. The refractometer can be used to measure the degree of hydrogenation of fats and oils, the sugar content of fruit juices, beverages and syrups, the salinity of brine solutions or for liquid chromatographic detectors, ion exchange measurements and molecular weight determination.

* * *

P-12-3—A compact High Precision Bridge Console for comprehensive audio-frequency measurements, incoporating four to six instruments as may be required, has been introduced by Wayne Kerr Corp. The new bridge console forms a complete measuring station and includes all that is required for rapid and convenient investigations of impedances at audio frequencies. Range of the High Precision Bridge Console is from 20 micro-ohms to thousands of megohms, to an accuracy of 0.01 percent. Comparisons of impedances can be made to an accuracy of 0.001 percent. The console can be fitted with the Wayne Kerr instruments best suited to individual requirements. The usual full complement includes: the Type S-121 Audio Signal Generator; the B-821 High Precision Low Impedance Comparator; B-921 High Precision High Impedance Comparator; the B-221 Universal Bridge, the B-321 Low Inductance Bridge; and the A-321 Waveform Analyzer. A separate meter is supplied for insertion at any working station. This meter provides a convenient means of determining bridge balance. Dimensions of the Bridge Console are 3 feet 4 inches high, 7 feet 3 inches wide; and 4 feet, 9 inches deep.

P-12-5—A new ultra-sensitive exposure meter for photomicrography, known as "REMIPHOT", is now available. The meter can be used for exposure measurement with any camera - microscope combination. This universal application becomes possible through the use of an instrument factor, or "index", which depends on the type of microscope and camera used. The Remiphot measures an integrated light value that is a mean value of the light intensity in the plane of the film. The minimum light intensity which can be measured is approximately 0.1 microlumen; the maximum value is several million times greater. The exposure time scale is graduated from $\frac{1}{500}$th second to 4 hours.

* * *

P-12-7—A new transfer volt ammeter has been added to the Hermach-Engelhard instrument family. The new instrument, Model C, is capable of making precision measurements of alternating or direct currents and voltages within an accuracy of 0.05 percent, through the frequency range from 5 to 50,000 cycles per second. The instrument, which can be used to calibrate laboratory standard equipment, is available with various plug-in accessories which extend the frequency range to 30 megacycles. The model C instrument has two sets of eleven ranges, one which covers voltages from 0.5 to 1500 volts and another which covers current from 7.5 milliamperes to 25 amperes. For the convenience of the customer who is concerned with only voltage measurements or only current measurements, a modified version of the instrument is provided at a reduced cost. The Model C qualifies for a National Bureau of Standards certificate which may be obtained at nominal cost. Provisions are made for determining the AC-DC differences of other instruments to an accuracy of 0.02 percent. The measurements are obtained from dial settings as guided by a null galvanometer. This eliminates errors which would otherwise be inherent in an indicating instrument. The Model C meter has been designed to meet increased accuracy demands by providing a means of equating the heating effect of the unknown current to be measured to the heating effect of a known current. The null galvanometer establishes the point of equality. Any standard potentiometer of appropriate accuracy is used to measure the direct current against which the unknown value has been related.

* * *

P-12-6—Automatic grading and marking of lumber is one of the

Steps of Quality Control

The Tubular Products Sub-committee of the Metals Technical Committee of ASQC has received permission from D. Evans to reproduce "Steps of Quality Control."

In the opinion of the sub-committee, this document is an outstanding example of a product oriented training aid for use in the introduction of fundamental statistical quality control in the tube and pipe mill. The document has been used successfully for several years by one of the major tube producers.

The booklet is being distributed by the sub-committee as a technical service to the tube industry. Contact the chairman of the sub-committee — Walter T. Hayter, Youngstown Sheet and Tube Co., East Chicago, Indiana.

potential uses of a recently developed device called the Acoustigraph. This is of interest to the lumber industry because of the ruling by the Federal Housing Administration that all lumber used after April 15, 1960 in FHA-approved homes must be graded and marked. The Acoustigraph transmits acoustic energy through low density materials such as concrete, plastic, rubber, and wood. Where less sound energy penetrates the inspected object, a dark area appears on electro-sensitive paper. The dark area represents a flaw. For many materials, the Acoustigraph is far more sensitive than X-ray. Since no film development is required, test results are available immediately. The contrast and differential sensitivity in the final record is easily controlled and there are no high voltage and radiation hazards. The Acoustigraph was originally developed to inspect rocket propellants. However, the combination of basic principles used are applicable to a wide variety of inspection problems. The permanent record is in the form that is easier to interpret and to correlate than conventional ultrasonic displays.

* * *

P-12-10—The American Hydromath Corporation has developed a new circular slide rule called Qualitrule, which is an aid in applied statistics, and particularly industrial quality control. This new and unusual "Quality Control Computer," presents in one setting the upper and lower limits for the number of defectives (rejects) to be expected in a sample of given size, provided the sample is taken at random from a much larger "population" having a certain over-all average percent defective. These limits depend upon sample size and overall range. The slide rule covers sample sizes from two to 1000, averages from 0.3 to 20 percent, upper limits from two to 200 units, and lower limits from zero to 50 units. All figures are directly read off without any intermediate computation whatsoever. For any one set average, the limits can be read for all sample sizes without moving the slide rule. It presents the numerical relations based on probability equations as given, for example, in Dodge and Romig, "Sampling Inspection Tables," (page 44, equations 4 and 5), rather than on any of the several approximation formulae now widely used. It is seven inches in diameter and all scales appear on one side of the computer. Contrasting colors enhance readability and ease of setting. Price $4.95.

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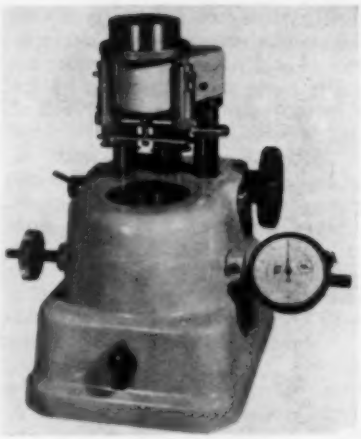

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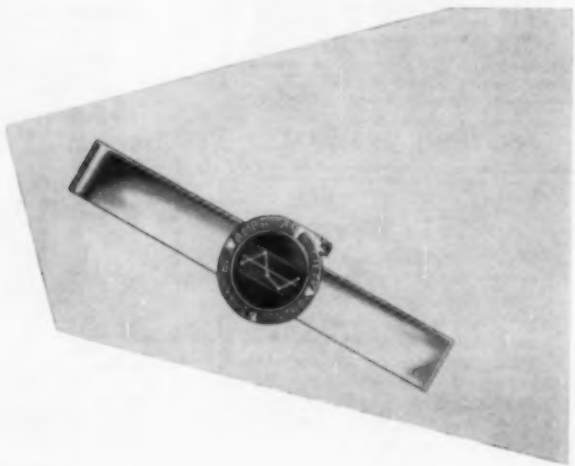

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. . . 26—Windsor All Day Quality Control Forum at the Cleary Auditorium and Memorial Convention Hall, Windsor, Ont., Canada, sponsored by the Windsor, Ont., ASQC section. Contact Kenneth Crew, 464 Mathew Brady, Riverside, Ont., Canada.

DECEMBER

. . . 1—One Day Seminar on the latest developments in QC tools for the process industries, MIT Faculty Club, sponsored by the Boston ASQC section, contact Robert Fabian, 256 Plain St., Rockland, Mass.

. . . 3—16th Annual Conference, Princeton, N.J., co-sponsored by the ASQC Metropolitan section and the ASA Physical and Engineering Sciences section under the chairmanship of Thomas E. Shahnazarian. Contact Mr. Shahnazarian, quality engineer, General Tire and Rubber Co., Akron, Ohio.

. . . 5-7—Three Day Forum sponsored by the American Management Association at the AMA Academy, Saranac Lake, N.Y. Conference theme —meeting the threat of foreign competition. The briefing will feature several case studies of successful company selling programs. Topics will include the impact of imports on American markets, defining areas where foreign competition enjoys an advantage and where it is at a disadvantage, how American industry can defend itself, possible government action, and opportunities for mutual protection between U.S. and foreign business. Contact AMA, 1515 Broadway, Times Square, New York 36, N.Y.

. . . 7—First Annual Insulation Progress Dinner, Conrad Hilton Hotel, Chicago, Ill., sponsored by the Insulating Materials Division of the National Electrical Manufacturers Association (NEMA). Maj. M. E. Griffith, chief of test operations, USAF Ballistic Missile Division, Cape Canaveral, Fla., will discuss "The Applications of Electrical and Electronics Equipment in Missile Launching," emphasizing the role of insulating materials in today's space age. Contact NEMA, 155 East 44th St., New York 17, N.Y. Tickets $10. Checks payable to "NEMA Dinner."

. . . 7-9—65th Annual Congress of American Industry, Waldorf-Astoria, New York, N. Y., sponsored by the National Association of Manufacturers. Contact NAM, 2 East 48th St., New York 17, N. Y.

. . . 12-15—Winter Meeting of American Nuclear Society at the Mark Hopkins Hotel, San Francisco, Calif., contact American Nuclear Society, 86 East Randolph St., Chicago 1, Ill.

. . . 13-15—Tenth Annual Eastern Joint Computer Conference (EJCC), Hotel New Yorker and Manhattan Center, sponsored by the National Joint Computer Committee, which consists of representatives of the Institute of Radio Engineers, the American Institute of Electrical Engineers, and the Association for Computing Machinery. Contact P.O. Box 2580, Grand Central Station, N. Y. 17, N.Y.

. . . 14-16—Second Annual Seminar on Color Control for the Graphic Industries at the Rochester Institute of Technology, Rochester, N.Y. Topics include fundamentals of color, color specification, illumination, color vision, inspection and process control. Contact Harold Kentner, director of Extended Services, Rochester Institute of Technology, Rochester 8, N.Y.

JANUARY

. . . 8—Measurement Series on eight consecutive Monday evenings at the Wentworth Institute, sponsored by the Boston ASQC section, contact Robert Fabian, 256 Plain St., Rockland, Mass.

. . . 9-11—Seventh National Symposium on Reliability and QC, Bellevue-Stratford Hotel, Philadelphia, Pa., sponsored by the IRE, AIEE, EIA, and ASQC. Contact R. L. Schwarin, vice chairman, publicity committee, ACF Electronics Div., ACF Industries, Inc., 11 Park Place, Paramus, N.J.

. . . 11-12—Two Day National Seminar on Quality Control, St. Louis, Mo., co-sponsored by ASQC and ASTME, contact ASTME, 10700 Puritan, Detroit 38, Mich.

. . . 16-18—Fifth ASQC Workshop-Seminar, Penn Sheraton Hotel, Pittsburgh, Pa., Paul C. Clifford, director, professor at Montclair State College. Address inquiries to: Fifth ASQC Workshop-Seminar, ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.

. . . 16-19—ISA Winter Instrument-Automation Conference & Exhibit, Sheraton-Jefferson Hotel and Kiel Auditorium, St. Louis, Mo., contact William H. Kushnick, executive director, ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

. . . 23—Ten day 1961 Engineering and Management Course, UCLA campus, contact Reno R. Cole, coordinator, College of Engineering, University of California, Los Angeles 24, Calif.

. . . 24-27—17th Annual Technical Conference of the Society of Plastics Engineers, Shoreham Hotel, Washington, D.C. Contact SPE, 65 Prospect St., Stamford, Conn.

. . . 28—10th Annual Quality Control Conference, Cincinnati, Ohio, sponsored by ASQC Cincinnati and Hamilton-Middletown sections. Topics include management relations to QC; QC in the bulk industries (food, chemicals, paper, etc.) and QC in mechanical and metal industries (hard goods, electronics, etc.), contact Hubert T. Cornish, 7276 Rita Lane, Cincinnati 43, Ohio.

FEBRUARY

. . . 9—Thinking Tools for Engineers Series for ten consecutive Tuesday evenings, location to be announced, sponsored by the Boston ASQC section, contact Robert Fabian, 256 Plain St., Rockland, Mass.

. . . 14—One Day Clinic at the Hotel Lowry, St. Paul, Minn., sponsored by the Minnesota ASQC section, contact Kenneth L. Sundeen, Minneapolis Honeywell Regulator Co., 2753 4th Ave. South, Minneapolis, Minn.

. . . 18-20—Eleventh Annual Textile Division Conference, Clemson House, Clemson, S.C., contact R. G. Mitchell, International Latex Corp., Dover, Del.

MARCH

. . . 6-8—Data Processing Conference, Statler Hilton Hotel, New York City, sponsored by the American Management Association. Contact AMA, 1515 Broadway, Times Square, New York 36, N. Y.

. . . 8-10—11th Annual ISA Conference on Instrumentation for the Iron and Steel Industry, Roosevelt Hotel, Pittsburgh, Pa. Contact Richard R. Webster, Jones & Laughlin Steel Corp., Research Laboratory, 900 Agnew Ave., Pittsburgh 30, Pa.

. . . 10—Joint ASQC-AIIE Seminar "The Breakthrough to Higher Levels of Performance," Western Skies Hotel, Albuquerque, N. M. Contact Joe McDowell, 604 Amherst Dr., S. E., Albuquerque, N.M.

. . . 20-24—Twelfth Western Metal Congress and Exposition, Pan-Pacific Auditorium, Los Angeles, Calif., sponsored by American Society for Metals, Metals Park (Novelty), Ohio.

. . . 27-31—3rd Symposium on Temperature—Its Measurement and Control in Science and Industry, Veterans' Memorial Hall and Deshler-Hilton Hotel, Columbus, Ohio. Sponsored by ISA, American Institute of Physics, and National Bureau of Standards. Contact ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

QC Papers Scheduled for Plastics Conference

Special papers on "Statistical Quality Control and Design of Experiments" have been scheduled during a session of the 17th Annual Technical Conference of the Society of Plastics Engineers.

The Conference, which will incorporate more than 125 technical papers comprising more than 30 sessions, will be held Jan. 24-27, at the Shoreham Hotel, Washington, D.C.

The QC session will cover topics as analysis of variance in processing, molding and testing, the role of statistics in setting specifications, and acceptance sampling by attributes and variables.

As in previous years, technical sessions will be terminated in mid-afternoon to permit ample time for the annual meetings of the Society's 15 Professional Activity Groups.

APRIL

. . . **6-8—Sixth ASQC Workshop-Seminar, Hotel Roosevelt, New York City, Paul C. Clifford, director, professor at Montclair State College. Address inquiries to: Sixth ASQC Workshop-Seminar, ASQC, 161 W. Wisconsin Ave., Milwaukee 3, Wis.**

. . . **12-14**—Third Symposium on Information and Decision Processes, Purdue University, Lafayette, Ind. Contact Purdue University.

. . . **17-19**—7th National ISA Symposium on Instrumental Methods of Analysis, Shamrock-Hilton Hotel, Houston, Texas. Contact ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

. . . **30-May 4**—7th National Aero-Space Instrumentation Symposium, Adolphus Hotel, Dallas, Texas. Contact W. J. Gabriel, Group Engineer, Convair Division, General Dynamics Corp., Fort Worth, Texas.

MAY

. . . **9-11**—1961 Western Joint Computer Conference, Ambassador Hotel, Los Angeles, Calif. Papers on systems, applications and circuitry for both digital and analog computers. Submit summaries of papers by Dec. 15 to C. T. Leondes, associate professor of engineering, Department of Engineering, University of California, Los Angeles 24, Calif.

. . . **22-26**—Annual Conference of the Society of Photographic Scientists and Engineers, Arlington Hotel, Binghamton, N.Y. Contact SPSE, Box 1609, Main Post Office, Washington, D.C.

JUNE

. . . **26-July 1**—International Measurement Conference at the Engineering Societies Bldg., Budapest, Hungary. Proposals concerning papers to be read or inquiries concerning details should be directed to J. Johnston, Jr., president of the Instrument Society of America, Dupont de Nemours, Wilmington 98, Delaware, or write directly to IMEKO Secretariat: Budapest, 5. POB 3.

. . . **28-30**—Second Joint Automatic Control Conference, University of Colorado campus, Boulder, Colo., sponsored jointly by ISA, AIChE, AIEE, ASME and IRE. General program chairman is H. M. Paynter, Mechanical Engineering Department, Massachusetts Institute of Technology. Authors are asked to send brief abstracts promptly to the program chairmen of their representative society. These program chairmen are: ISA—J. L. Harned, Research Laboratory, GMC, Warren, Mich.; AIChE—Nathan Gilbert, Chemical Engineering Department, University of Cincinnati, Cincinnati 21, Ohio; AIEE—Kan Chen, New Products Laboratory, Westinghouse Electric Corp., P.O. Box 10596, Pittsburgh 35, Pa.; ASME—R. E. Kalmzn, 7212 Bellona Ave., Baltimore 12, Md., and IRE—Robert Kramer, MIT, Cambridge 39, Mass. Contact ISA, 313 Sixth Ave., Pittsburgh 22, Pa.

ASQC Annual Convention

Future Dates

June 5-7,	**1961**	**Philadelphia**
May 23-25,	**1962**	**Cincinnati**
May 20-22,	**1963**	**Chicago**
May 4-6,	**1964**	**Buffalo**
May 4-6,	**1965**	**Los Angeles**
June 1-3,		**New York**

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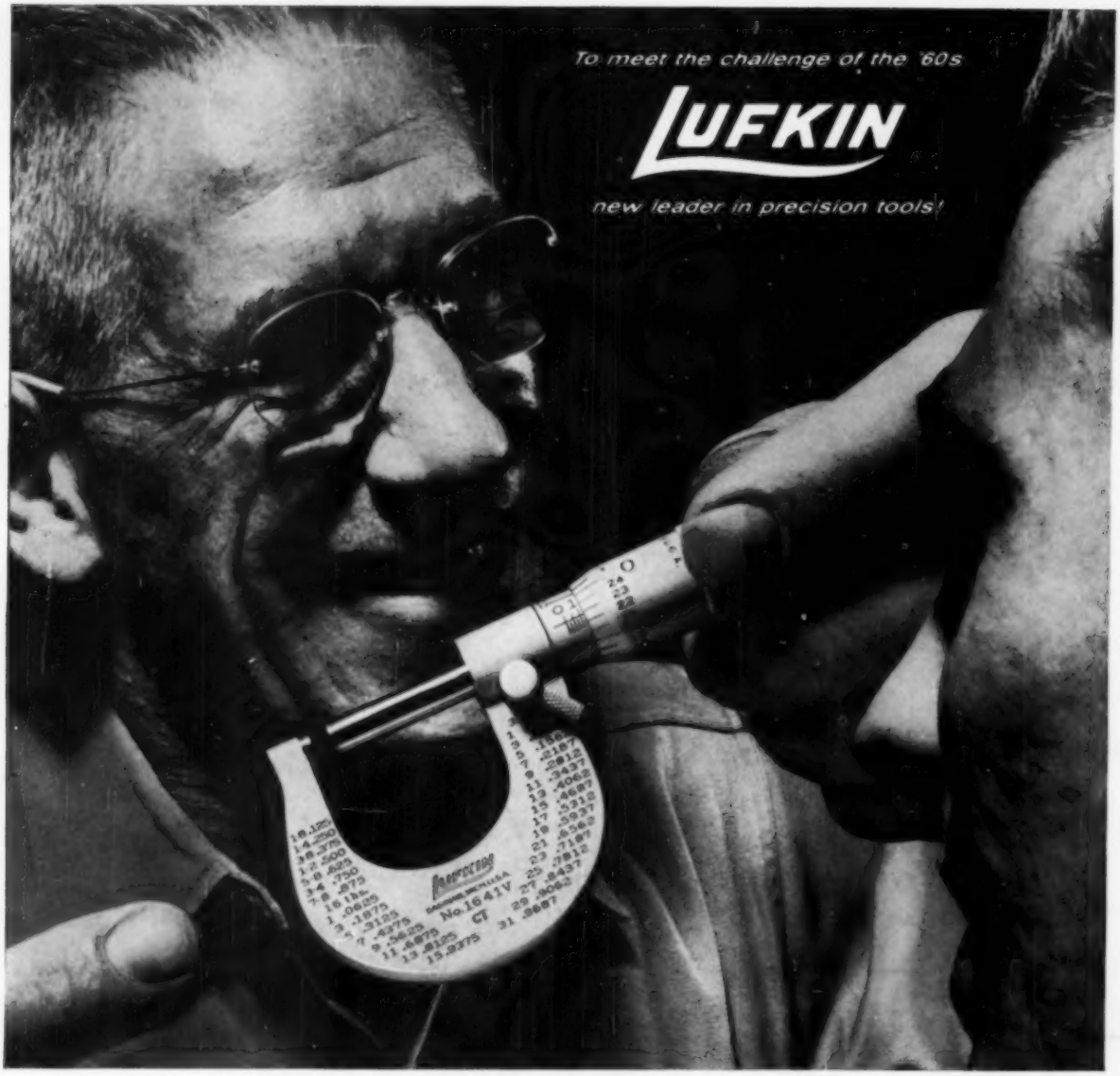

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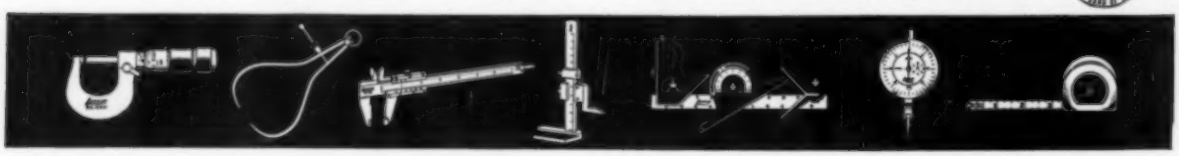
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